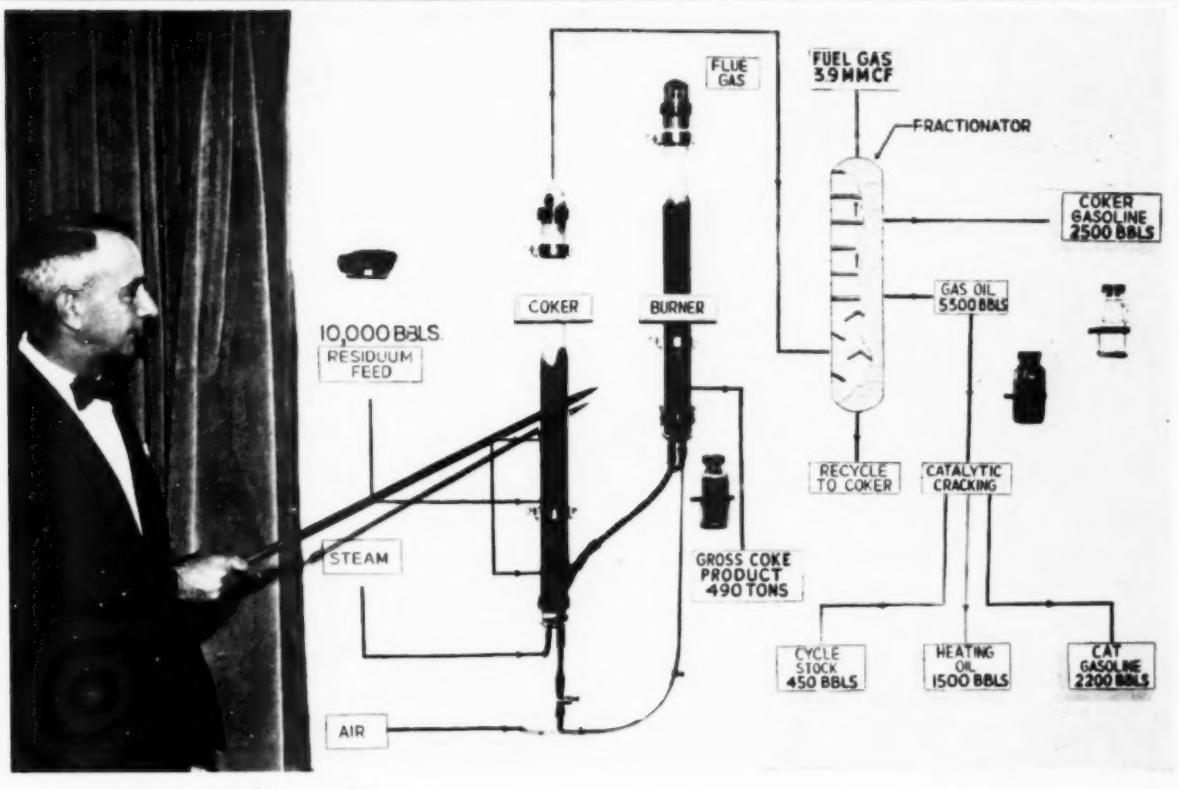
PETROLEUM PROCESSING

including Petrochemical Processing Section

SEPTEMBER 1953



New Coking Process gives high yields of liquid products, p. 1316

Pacific Northwest Outlook

Refining capacity to hit 158,050 b/d by 1955; up 250%—p. 1313

How to Buy Electric Motors

No. 8 in a series of tips for ordering equipment properly—p. 1318

A McGRAW-HILL PUBLICATION

There is only one, and he is HOME ASLEEP!

In this self-sufficient plant the "Operators" are built into the plant — a human operator is required only for loading products and routine maintenance. During the night unusual changes in pressures or levels cause the warning ringing of the bedside telephone of the resident operator.

The plant, operating in the Ropes Field of Hockley County, West Texas, is designed to compress and dehydrate 4 million cubic feet of gas per day, extract 67% of the propane, and produce three liquid products totaling 35,000 gallons per day.

The special features to reduce operating costs and minimize capital investment without sacrifice of propane recovery, safety or continuity of operation were developed by HUDSON in collaboration with the engineers of Honolulu Oil Corporation to solve the problem of economically processing small quantities of rich gas.

General view of plant showing HUDSON Combin-aire unit at left.

HUDSON
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The burning question

What happens when a charge of gasoline vapor is ignited in an automobile engine? What chemical compounds are formed and broken down, what complicated reactions take place as atoms and molecules perform their dance of heat and pressure and power?

Today nobody truly knows. But until this "burning" question is answered, there is an inevitable ceiling on improvements in fuels and engine design. So research laboratories all over America are hard at work on the problems of combustion.

At Ethyl's Detroit laboratories a team of chemists and engineers have specialized on this basic research in combustion for a number of years. In their attacks

(continued on next page)

Printed in U.S.A.

The burning question

(*Continued from preceding page*)

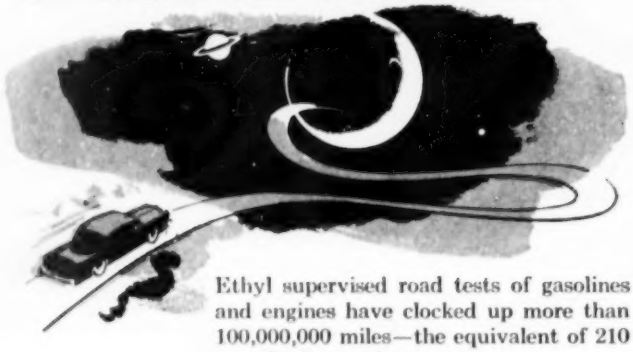
on the problem, they have developed special instruments for measuring pressures and temperature—and for sampling of the mixture in the cylinder. They have devised new types of laboratory tests, and already many new facts have been obtained—which we have passed along to the petroleum and automotive industries.

Also, because of Ethyl's unique association with the petroleum and automotive industries, we have been able to participate in cooperative programs with both of them. For here is a problem—or rather a collection of problems—that is a match for the combined efforts of a vast number of researchers.

Someday we will all know what goes on during combustion. It is a dream worth working for. But until that day comes, Ethyl laboratories will continue its intensive research on "the burning question," and supply you the answers as they are found.

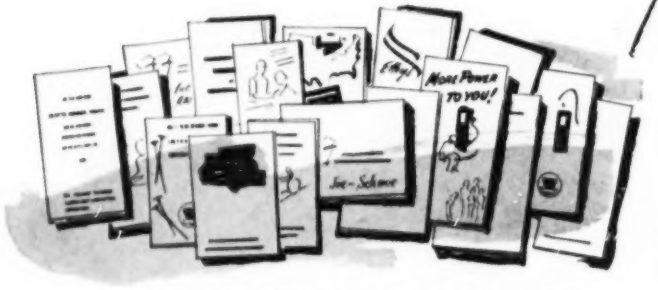
ETHYL CORPORATION
NEW YORK 17, NEW YORK

WORTH NOTING



Ethyl supervised road tests of gasolines and engines have clocked up more than 100,000,000 miles—the equivalent of 210 round trips to the moon.

Ethyl's research people alone have a combined antiknock experience of 5232 years. For one man to have all this experience he would have to have lived nearly six times as long as Methuselah.



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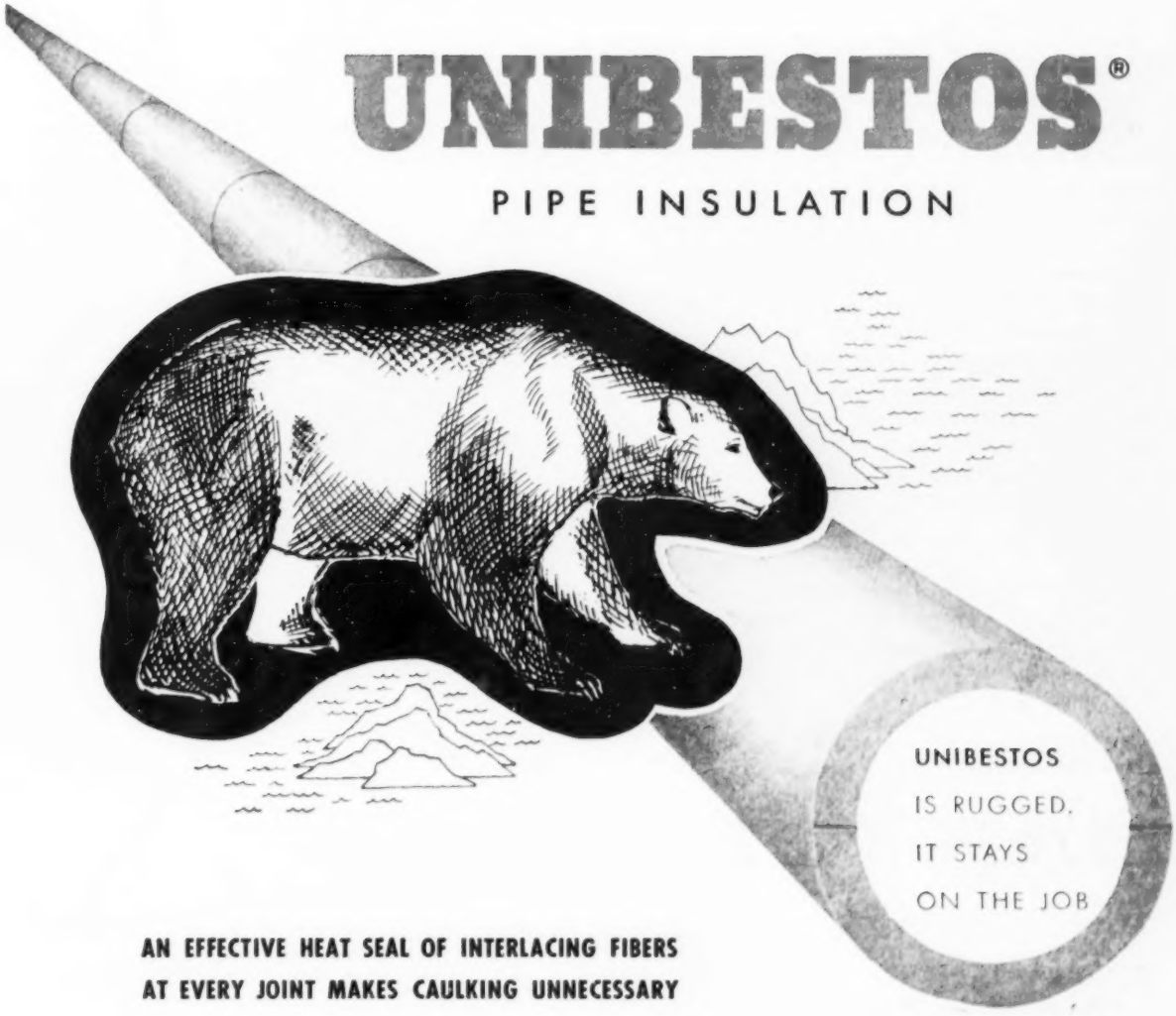

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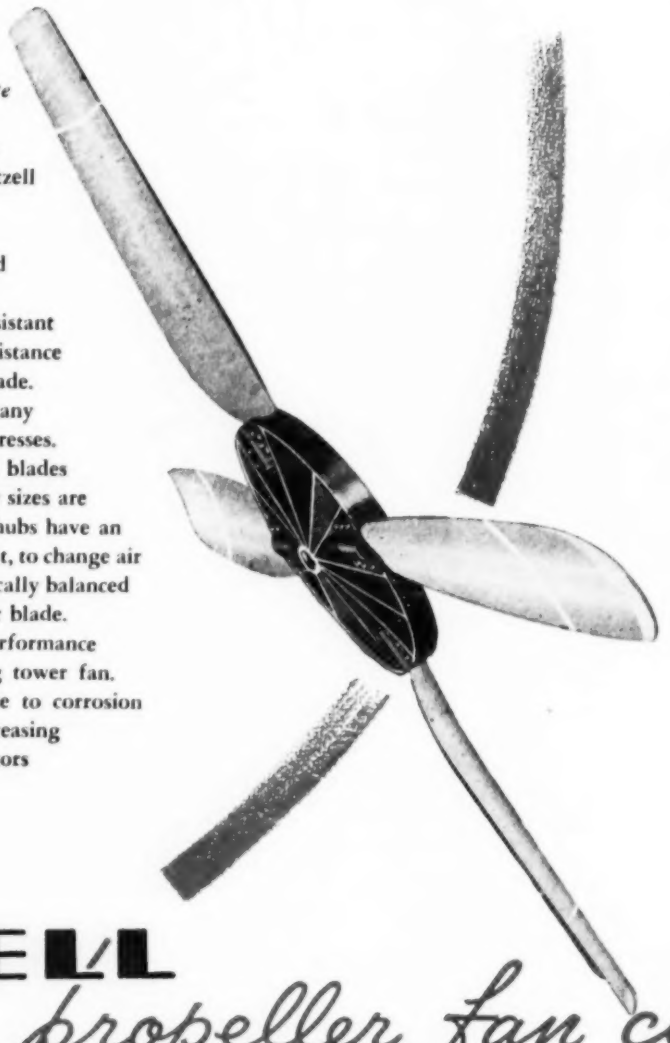
Why the Petroleum Industry Prefers HARTZELL Cooling Tower Fans



Nearly every Hartzell cooling tower fan installed since the introduction of the Hartzite plastic blade in 1941 is still in service. This proven dependability explains why the plant which has had experience with one Hartzell fan will almost invariably insist on more Hartzells as other fans need replacement.

Fabric-base Hartzite plastic was developed especially to meet the rugged requirements of the petroleum industry. It is unusually resistant to corrosion and abrasion. Durability and resistance to corrosion are constant throughout the blade. Hartzite absorbs vibration. Its strength is many times that necessary to withstand normal stresses.

Hartzell cooling tower fans with Hartzite blades are available in sizes from 10′ to 22′. Smaller sizes are made of aluminum alloy. The welded steel hubs have an extremely high safety factor. Blade adjustment, to change air delivery, is easily made. All hubs are dynamically balanced and all blades are balanced against a master blade.

You no longer have to rely on claims. Performance has proven that Hartzell makes *the* cooling tower fan. Recognition of Hartzell's superior resistance to corrosion and mechanical damage is found in the increasing frequency with which cooling tower operators specify simply "Hartzell fan."

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PETROLEUM PROCESSING

Covering petroleum and petrochemical research and the design, construction, management, operation and maintenance of plants processing hydrocarbon materials into fuels lubricants and chemicals.

September, 1953
Vol. 8, No. 9

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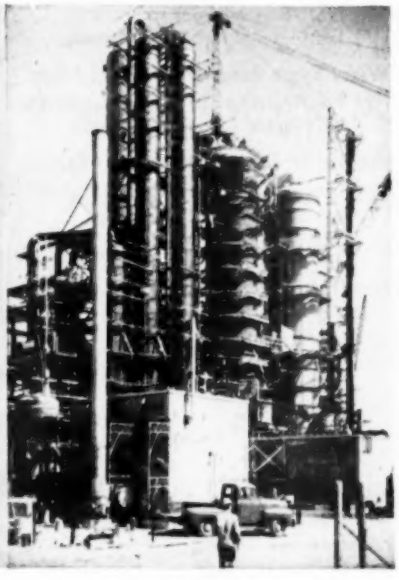
PUTTING EXPERIENCE TO WORK TODAY. Today, Lummus is handling many different petrochemical and chemical projects—putting years of background experience to use in the light of today's competitive situations and technological advances. For example, the modern ethylene plant shown here is one of twelve Lummus projects in this field alone, including the world's largest unit. As a measure of engineering versatility, other recent Lummus projects are facilities for making phthalic anhydride, ethyl chloride, dichlorethane, formaldehyde, ethyl benzene, styrene monomer, isopropanol, phenol, acetone, carbon black, ammonia, aliphatic and cyclic alcohols.

SOMETHING YOU CAN USE. Lummus offers you competent experience in plants discussed on this page, as well as in modern process units for making such chemicals as ethylene oxide, ethylene glycol, acetylene, chlorinated hydrocarbons and urea.



If you're thinking of new or improved chemical facilities, Lummus can help you. A discussion with us may prove profitable to you.

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PETROLEUM PROCESSING

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Petroleum Processing is published the second Tuesday of each month by McGraw-Hill Publishing Co., Inc., James H. McGraw (1860-1948) founder.

Editorial, Advertising and Subscription Offices: 1213 West Third St., Cleveland 13, Ohio.

Publication Office: 1309 Noble St., Philadelphia 23, Pa.

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Subscription Rates: Domestic single copies, 35¢. United States and possessions, $2 per year, $3 for two years, $4 for three years; Canada, $3 per year, $4 for two years, $5 for three years; Latin America, $8 per year, $12 for two years, $16 for three years; all other countries, $10 per year, $16 for two years, $20 for three years.

Published prior to Sept. 1946 as the Technical Section of National Petroleum News, devoted to Refinery Management and Petroleum Chemical Technology, and including International Petroleum Technology. Acceptance under section 34.64 P.L.&R. authorized. Printed in U.S.A. Copyright 1953 by McGraw-Hill Publishing Co., Inc. All rights reserved.

Same Things, Same Place—But a New Face

IF YOU haven't already noticed it in the little chunk of this issue you've seen so far, you'll pretty soon be aware that we've done a bit of face-lifting on PETROLEUM PROCESSING.

The biggest change we've made is to start using a new type face for our body type—and we've stepped it up in size. In the past we've used an 8 point Ideal—now we're using 9 point Times Roman. Aside from being an easier type face for you to read, there's another plus value for you. Since it takes up a bit more space (12.5%, to be exact), we can't get as many words on a page. That means that to give you the same amount of information in each issue (which we certainly intend to do—and then some) we've got to write our stories more tightly—and use fewer words to say the same thing. We'll have to be more specific and terse.

We've also made a few other changes in type faces for headings and in our general page layout—but they are relatively minor and unless you're a printer or student of typography you'll probably never notice them.

All of these changes have come about because of another change—our printer. PETROLEUM PROCESSING since its inception has been printed right here in Cleveland in the same building in which we have our editorial offices. Now we're printing in the shops of Periodical Press in Philadelphia. You probably noticed that your copies of PETROLEUM PROCESSING have been reaching you as much as a week later than they used to in recent months. One reason for switching printers was to correct that situation.

Switching over to a new printer has had its complications, not the least of them being the problem of getting copy and proofs and dummies back and forth between Cleveland and Philadelphia. We tried regular train mail, air mail, and even air mail special delivery—but none of them proved either dependable or fast enough.

We've finally set up our own private system. Every afternoon at 5 we pack our mail pouch with copy and other material for the printer, and then our trusty mail boy lugs it down a few blocks and puts it in the care of Railway Express. With the cooperation of the Pennsylvania Railroad and its Train No. 38, our pouch is in North Philadelphia the next morning at 6:55, where our printer's mail boy picks it up and has it in the plant when it opens at 8 a.m.

So far we haven't missed a train or lost a pouch. Just call us "Pony Express!"

William F. Bland

For the Editors

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What's Happening...

Refinery Expansion

. . . **Pressure for more alkylate capacity** is being put on the industry. Last month Petroleum Administration for Defense sent letters to selected oil companies asking them to consider construction of alkylate facilities. Letters went to those firms which had been indicated in a previous study to have necessary feedstocks available for making alkylate. Earlier in month, PAD official stated that government might build needed facilities if private industry fails to provide sufficient capacity. PAD also indicated that lack of alkylation facilities where feasible and economic might be cause for rejecting requests for fast tax write-offs on basic refining facilities.

. . . **Standard of California** is launching a $30-million refinery expansion program "to increase quality and octane ratings of motor gasoline." Program includes two "large" catalytic reformers—one each for Richmond, Calif., and El Segundo, Calif. Type and capacity of units have not yet been decided, nor have construction dates been set.

. . . **Carter Oil Co.** will install first unit to employ new Fluid Coking Process developed by Standard Oil Development Co. and described for the first time in this issue (p. 1316). Carter unit will have charge capacity of 3,000 b/d. Both Carter and Standard Oil Development are subsidiaries of Standard Oil Co. (N. J.).

. . . **Esso Standard Oil Co.,** another Jersey subsidiary, will also install Fluid cokers—a 10,000 b/d unit at its Baltimore, Md., refinery and a 20,000 b/d unit at its Baton Rouge, La., refinery.

. . . **Phillips Petroleum Co.** will build a new 16,000 b/d UOP Platformer at its Sweeny, Texas, refinery. Construction will be handled by Procon, Inc., and is expected to begin early next year, with completion scheduled late in '54.

. . . **Shell Oil Co.** will build a 4,500 b/d UOP Platformer at its 55,000 b/d Martinez refinery—the third such unit to be installed by Shell (others are at Wood River and Houston). C. F. Braun & Co. is contractor on project, which will cost an estimated $1,700,000. Construction will start immediately, with completion scheduled for July '54.

. . . **Union Oil Co. of Calif.** will build a $450,000 lube oil blending plant at Willbridge (outside Portland), Oreg., to include blending and homogenizing equipment, tankage, barrel conveyor, and allied facilities. Blending stocks will be brought up from California in bulk. (For an up-to-date appraisal of expanding petroleum processing facilities in the Pacific Northwest area see pg. 1313 of this issue, for the report by Frank Breese, our West Coast Editor.)

. . . **Cosden Petroleum Corp.** has let mechanical design and construction contracts for its new 1,960 b/d HF alkylation unit at Big Springs, Texas, to Refinery Engineering. (See "What's Happening," July, pg. 967.) A $3,115,000 certificate of necessity for the project was granted last month.

. . . **Pennzoil Co.** has awarded M. W. Kellogg Co. construction contract for $2-million expansion program at its No. 1 plant at Rouseville, Pa. Plans include construction of new two-stage crude distillation unit with 9,000 b/d rated capacity and 12,000 b/d maximum capacity, replacing three old units with combined capacity of 10,500 b/d. Two boilers also will be replaced. Work on the new unit will start next month and be completed in nine months.

. . . **Derby Oil Co.** is considering installation of a 980 b/d alkylation unit, 2,000 b/d catalytic reformer, and recovery facilities to produce toluene concentrate at its Wichita, Kans., refinery. Certificate of necessity has been issued for project, at value of $2,694,350.

. . . **Union Oil Co. of Calif.** has taken an option on 3,250 acres of land northwest of Santa Maria, Calif., as a possible site for a coking plant for preliminary processing of heavy, sulfurous Santa Maria crude. Before exercising option, company plans to check adequacy of water supply by drilling several water wells.

. . . **Shell Oil Co.** has awarded contract to Fluor Corp. for second major expansion of the Elk City, Okla., cycling plant, of which Shell is operator for the 14 owners. At a cost of over $1,500,000, plant's gas throughput will be increased by 75,000 Mcfd. (to 225,000 Mcfd.), and recovery of liquid hydrocarbons by 95,000 gal./day (about 50%).

. . . **American Bitumuls and Asphalt Co.** plans a new asphalt refinery near Cincinnati, Ohio. Plant will process a high-grade asphaltic crude imported from Venezuela, and will include a two-stage distillation unit, administration building and laboratory facilities, plus 1,100,000 bbls. storage capacity. Cost will be $4 million, but contractors and completion dates have not yet been announced.

. . . **Commonwealth Refining Co.** has announced plans for Puerto Rico's second refinery. (First was announced last month by Caribbean Refining Co., which plans a 10,000 b/d plant in San Juan, P.R.—see "What's Happening," Aug., pg. 1111.) Commonwealth's plans call for an authorized capital of $23-million, and a plant at Guayanilla Bay, near Ponce, to produce 10,000 to 16,000 b/d of gasoline. No other details on the plant have been released.

. . . **New petroleum processing plant expansions** to look for, as indicated by rapid tax amortizations announced last month:

Crown Central Petroleum, $1,495,000 for catalytic reformer for avgas at Houston.

Kerr-McGee Oil, $4,201,000 for 15,000 b/d crude unit, 8,500 b/d cat cracker, plus polymerization unit and auxil-

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

iary facilities at its refinery at Wynnewood, Okla.

Permian Petroleum, $3,545,000 to purchase shutdown refinery at Levelland, Texas, add vacuum unit and 2,695 b/d cat cracker, plus gas concentration and polymerization.

Pontiac Refining, $1,305,000 for 4,000 b/d catalytic reformer and auxiliaries at Corpus Christi, Texas.

Sunland Refining, $350,000 for 800 b/d catalytic reformer at Bakersfield, Calif.

Petrochemicals

. . . **Shell Chemical Co.** will build a completely new petrochemical plant at Norco, La., adjacent to Shell Oil's refinery there. New plant will produce allyl chloride and epichlorohydrin, the output of which will be used to increase Shell's glycerine production by 25 million lbs. annually. Propylene and other hydrocarbon feed stocks will be supplied by the refinery. Completion is set for late '54.

. . . **High-pressure hydrogenation of coal** for the commercial production of chemicals has won for Carbide and Carbon Chemicals Co. the 1953 Chemical Engineering Achievement award of *Chemical Engineering*, a McGraw-Hill publication. The process was announced 15 months ago and described in PETROLEUM PROCESSING in June '52, pg. 833. Paradoxically, Carbide and Carbon won the first Chemical Engineering Achievement award 20 years ago—for pioneering production of synthetic organic chemicals from petroleum and natural gas. The company's current work on hydrogenation is seen in some quarters as foreshadowing a resurgence in coal aromatics that could parallel the current petrochemical boom.

. . . **Petrochemical prices are dropping** under the impetus of large-scale production. Last month Monsanto announced a cut to 36¢/lb. (from 43¢) for acrylonitrile in tankcar lots. In another line, polyethylene, one end-product manufacturer announced an average 10% reduction in his price list for carboys and squeeze bottles.

. . . **Phillips Petroleum** is rumored to be taking a good long look at polyethylene—and is working in the pilot plant stage on a polymer which is hard, brittle and waxlike. Uses seen are for blending with flexible polyethylene to increase melting point, as a constituent of paraffin products, and for laminating paper and cloth.

. . . **Is Dow Chemical going into synthetic glycerin?** At present, Shell Chemical has a corner on the synthesis of glycerin, but Dow was recently granted a certificate of necessity for a $5,485,000 "glycerine" project at Freeport, Texas.

Markets, Prices

. . . **Ample supplies, light demand, easy prices**—that was the story in principal primary supply markets in August. The month is traditionally a quiet one for refined products. Consensus of reports this year, however, indicated it was an "unusually" slow month.

. . . **There were exceptions.** All types of residual fuel, for example, were in good demand in the Mid-Continent as railroad buyers sought supplies over and above contract commitments, and industrial users asked for increasing quantities of low sulfur oil. Heavy fuels also were strongest items in the Gulf Coast cargo market.

. . . **Natural gasoline was in good demand,** with refiners preparing for manufacture of winter grades of motor fuel, and Grade 26-70 prices jumped 0.875¢ a gal.—from 5.5¢ to 6.375¢, Group 3.

. . . **But the refiner's biggest money makers**—gasoline and distillate fuels—were in the doldrums. Both products were easy price-wise. Buyers are over the hump in meeting peak summer demand for gasoline, and summer-fill discounts on light fuels were having the reverse of the desired effect. Discounts offered by suppliers are good, in most areas, until end of September, and jobbers and distributors apparently are waiting until the last minute to get in under the wire. Rising distillate inventories as reported by API, and fact that gasoline stocks have shown only moderate declines during period of peak consumption, did not help to change the buyer mood.

Looking Ahead

. . . **A "fluidized" petrochemical process** is the next new application of Standard Oil Development's fluidized solids technique. The company is already studying changes in operating conditions of its newly announced Fluid Coking process (pg. 1316) to provide for making raw materials for ethylene, butadiene and other aliphatic chemicals. Nature of the charge stock will rule out the manufacture of aromatics, it is thought.

. . . **Measuring, sampling and testing methods** used by oil companies in checking crude and products will be reviewed and evaluated in a new API program expected to get under way within a few weeks. While there is a revised ASTM manual on measuring and sampling techniques, it is felt too little is known about the uniformity of methods in actual use and about the amount of work involved from the wellhead to the time the product reaches the consumer. H. C. Packard, Shell Oil Co., New York, is chairman of the special API committee, whose work will culminate in symposium on the subject at the 1954 annual API meeting.

. . . **Plans to pipe Texas crude to California** are being quietly dropped. Although two Texas-California crude pipe line projects are still kicking about, support for them has dwindled in inverse proportion to the increasing activity in the Pacific Northwest. For a current analysis of this latter area as a new refining center, see the report beginning on pg. 1313 in this issue.

. . . **Reopening of Abadan refinery** of Anglo-Iranian Oil Co., assuming agreement is reached between British and Iranians, will take a minimum of nine months, according to experts—and probably more. Information reaching us indicates that practically everything in the plant which could be moved by hand has been moved—out. Only a skeleton is said to remain, and a rusty one at that.

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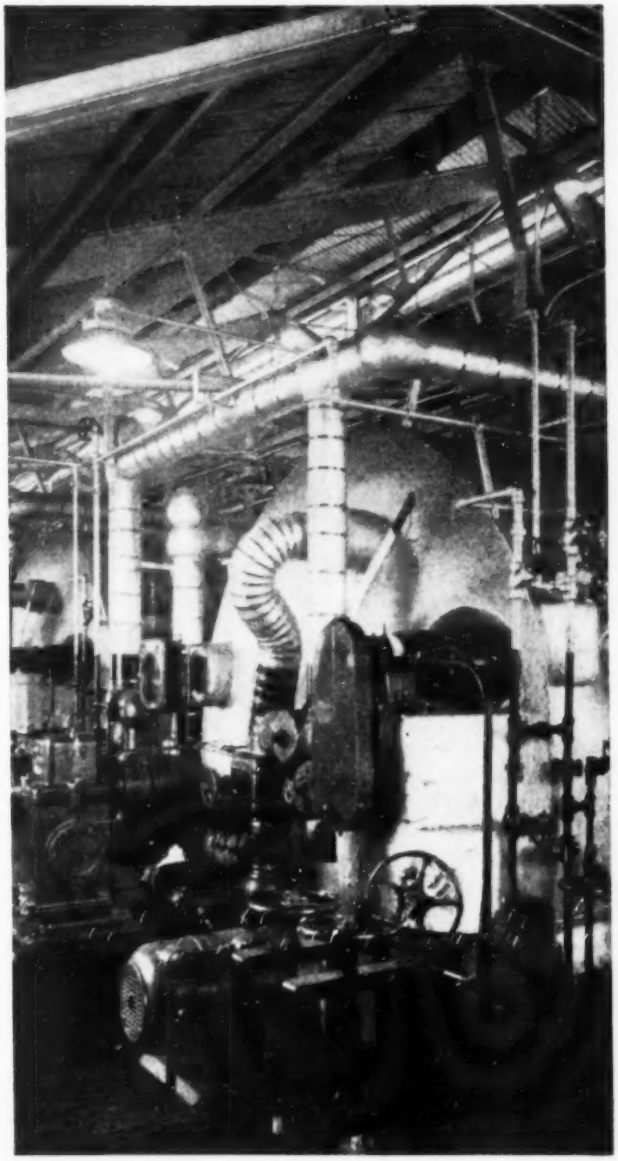

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PARANOX	PETROHOL 91	PETROHOL 91
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PARAPOID	Secondary Butyl Alcohol	Iso-Octyl Alcohol
PARADYNE	Secondary Butyl Acetate	Decyl Alcohol
PARATAC	Isopropyl Acetate	Tridecyl Alcohol
PETROHOL	Acetone	Dicyclopentadiene
Methyl Ethyl Ketone	Methyl Ethyl Ketone	Isoprene
Dewaxing Aid	Ethyl Ether	Butadiene
Ethyl Ether	Isopropyl Ether	Benzene
Isopropyl Ether	Dicyclopentadiene	Ethyl Ether
Reference Fuels	Naphthenic Acids	Isopropyl Ether
	Iso-Octyl Alcohol	Tripropylene
	Decyl Alcohol	Tetrapropylene
		Aromatic Tars
		Acetone
		Methyl Ethyl Ketone

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The Enjay Company has long been recognized as a leader in the development and marketing of high-quality products for the oil, surface coating and chemical industries. Backed by greatly expanded plant and distribution facilities, the Enjay Company is supplying a constantly growing list of chemical products to many different industries.

BE SURE TO CALL ON ENJAY FOR YOUR CHEMICAL NEEDS

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 (To obtain more data on advertised products see page 1400)

Enroute

GRAVER

PRECISION FABRICATIONS

meeting Industry's most exacting standards

STAINLESS CLAD TOWER

CARBON STEEL TOWER

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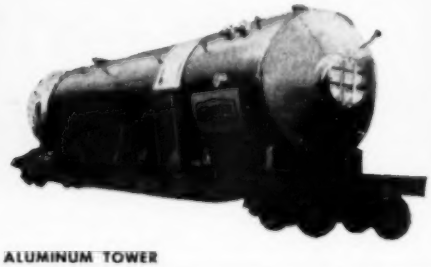

ALUMINUM TOWER

Where precision craftsmanship is required in tough-to-handle metals, you may rely on Graver. Nearly a century of experience in building tanks, combined with resourceful creative engineering, helps to explain the continuous flow of Graver vessels to the process and petroleum industries.

This is especially true in the fabrication of towers and vessels of alloys and aluminum. Here Graver's rigid quality control, sound welding research, and ability to work to close tolerances result in highest quality products. For *really difficult jobs,* look to Graver!

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PROCESS VESSELS

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

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Kerosine Seen as Favored Fuel For Commercial Jet Aircraft Use

IT is in the interests of both user and supplier that the fuel adopted (for jet transports) should not only be a product that is attractive to the airline from the standpoint of economy in operating costs, but that it should be a single grade acceptable to all airline operators."

In these words, a recent report[1] summarizes discussions with airline operators and most of the world's leading engine and aircraft manufacturers concerning the fuel which tomorrow's commercial jet transports will use.

"The fact that three or more different grades of aviation fuel are currently required for piston-engines transports has undoubtedly increased the costs of manufacturing and distributing aviation gasoline, a penalty that might well be avoided in selecting the fuel for jet transports."

From the standpoint of both cost and availability, it is pointed out, there will be a considerable price advantage to the operators of jet transports, if their fuel is a product which is already in world-wide distribution and is being handled at storage installations which are within reasonable access of the airports where it will be required.

The most universally distributed petroleum products are motor gasoline and kerosine, closely followed by automotive Diesel fuel. The report goes on: "It is believed that motor gasoline is not attractive as a potential civil turbine fuel on the grounds of its cost, vapor lock problems and potential fire hazard.

"The possibility of using automotive Diesel fuel is dependent on the future development of turbines which could use fuels in this boiling range without suffering severe penalties in respect to performance, reliability and maintenance costs, and is also dependent on its proving feasible to design aircraft which can handle a fuel with a freezing point of 15° F."

By process of elimination, of the universally available fuels kerosine is seen as the preferred from the standpoint of suitability. Apart from the relative combustion performance of different fuels, another property which is of considerable and probably vital importance is the actual freezing point of the fuel itself, in view of the unwillingness of aircraft manufacturers to install provisions for heating fuel. In this respect kerosine is believed to offer less difficulties than Diesel type fuels. The average freezing or cloud point of grades of kerosine generally available world-wide is given as —40° F., although, unless special grades were shipped to some areas, "it would probably prove difficult to guarantee on a world-wide basis a freezing point below —30° F."

On the basis of Btu values, at current market prices Diesel fuel would be lowest cost, next kerosine and JP-4 (U.S.A.F.) fuel and motor gasoline more expensive. "In arriving at a decision on the fuel to be selected, cost is not the only factor and the technical suitability of the fuel will necessarily override other considerations."

This authority estimates the maximum number of turbine transports that could be in world-wide operation by 1960-62 as 500, using a total of about 125,000 b/d of fuel. This would be barely 0.8% of the estimated world-wide (excluding Russia) production of crude by that time.

This discussion limits itself to jet fuels for commercial aircraft. The refiner will also have to concern himself with military requirements for this type of fuel, which this year will approach 150,000 b/d. His supply problem will be aided to the extent that operators of commercial jet aircraft can standardize on a grade generally available world-wide.

—V. B. G.

(1) "Fuel for Jet Transports," A. R. Ogston, Esso Export Corp., *Esso Air World*, July-August, 1953.

Jet Reactors Under Development For Producing Petrochemicals

ONE of the newest wrinkles coming to light in the processing field is the possible use of jet engines or "thrust chambers" as reactors for chemical processes—particularly in the manufacture of petrochemicals and other organic compounds.

Big strides have been made in the past decade, of course, in the development of jet propulsion for aircraft. These have resulted in the ramjet and turbojet engines and the rocket. In general, they all employ a thrust chamber in which fuel is burned rapidly and at temperatures ranging up to 5,000° F., with the combustion gases being ejected steadily at high speed from the chamber and resulting in propulsion of the chamber in the opposite direction. Pressure in the rocket chamber may be as high as 1,500 psi.

In the course of this development it has been observed that it is possible to obtain very rapid cooling of the combustion gases during their adiabatic expansion through the exhaust nozzle of the thrust chamber. This characteristic has led a number of scientists to investigate the possibilities of producing organic chemicals by arresting and trapping the transit compounds produced during the combustion reaction in the thrust chamber.

In a recent discussion of the subject[1] two professors at the U. of California described several broad classes of chemical reactions which are suited to thrust chambers:

"There are reactions which are sufficiently exothermic so that the pressure needed to effect the reaction can be developed in the combustion chamber. These reactions may not require expansion cooling of the products in order to 'freeze' the chemical equilibrium. However, such cooling may be desirable before subsequent processing.

"Then there are reactions which give satisfactory conversions at elevated temperatures but which require an extremely fast quench or reduction of temperature to 'freeze' the equilibrium. Here the expansion cooling is a vital essential to the success of the process. This type of reaction seems to be best suited for the thrust chambers and is likely to be the field now under investigation."

Experiment Inc., in Richmond, Va., they claim, has developed for Chemical Construction Co. a ramjet type of reactor for making ethylene and acetylene from hydrocarbon fuels.

Other sources have referred to the "jet pulse tube," in

which acetylene is drawn off under highly controlled conditions, the "jet chemical reactor," and the "high velocity gas reactor."

Development in this field is still in its infancy, and even though thrust chambers are cheap to build and can be designed for low maintenance there appears to be a problem in controlling the reaction. Nevertheless there seems to be little doubt that investigators are working hard to make the jet reactor a commercial reality—with improved yields, simplified processing, and lower costs.

—W. F. B.

(1) Paul Stewart and Frank Kreith, "What's Ahead for Jet Engines and Rocket Motors in Process Units?" *Chem. Engrg.*, Sept. 1953, p. 208.

Yardstick for Measuring Motor Fuel Vapor-Locking Tendency

THE Phillips Petroleum Co., which has been a leader among the petroleum and automotive companies in development work pertaining to the greater utilization of the lighter hydrocarbons from petroleum in motor fuels, has made another important contribution in this direction. This is in the form of a report[1] on work done by its research staff, with the chief objective of interpreting vapor lock data in terms of fuel system characteristics. To attain this objective it was necessary to develop a sound basis for the comparison of data from individual vapor lock road tests where several variable factors are always present.

Of particular significance in the report is the questioning of the suitability of Reid vapor pressure values for determining the vapor-locking characteristics of motor fuels.

The road test procedure followed in the work is the so-called "soak-type procedure," which since 1938 has been essentially standardized. This procedure involves: (1) a warm-up period of operation at a speed of 50-70 mph until fuel system temperatures are stabilized, (2) a soak period with the engine shut off to allow fuel system temperatures to rise, and (3) engine re-start and full-throttle acceleration to determine whether vapor lock will occur.

The method developed for converting data from individual vapor lock tests into related and comparable data includes: correcting for the effect of variations in ambient temperature, converting Reid vapor pressures to comparable values at an adopted reference temperature of 100° F., correcting for variations in barometric pressure, and the use of the slope at 10% evaporated in the ASTM distillation curve as representing the variable of fuel vapor locking characteristic.

The results are shown in an isovapor-lock plot, which was found to constitute the simplest method for accurate evaluation of the fuel vapor pressure for incipient vapor lock for each general fuel type tested.

By this method values can be obtained for a fuel system index and fuel system sensitivity, which supply the necessary information for the refiner to blend fuels having the desired balance of vapor pressure and volatility for optimum overall car performance. The data also provides better tools for the fuel system engineer to evaluate fuel systems in terms of vapor lock tendencies.

In the work of the Phillips investigators it was shown that fuels of the same Reid vapor pressure may differ considerably in their degree of protection against vapor lock and raised the possibility of the development of a more significant vapor pressure method to aid the refiner in his motor fuel blending practices.

The work of these authorities assumes even more importance for refiners and natural gasoline manufacturers if there is considered the possibility of their being called on in the future to make greater use of the more volatile materials in crude and natural gas liquids, in the event that jet fuel requirements take more of the middle portion of the barrel of crude.

—V. B. G.

(1) "Fuels and Fuel Systems," T. W. Legatski, O. C. Bridgeman, E. W. Aldrich and R. Rohde, Phillips Petroleum Co., Research Division, Bartlesville, Okla. Presented at Society of Automotive Engineers Summer Meeting, Atlantic City, June 7-12, 1953.

Plastics Settling Down to a Firm Footing as Industry Use Grows

PLASTICS, the "chemical wonder boy" of the past decade, has admittedly done its share toward spurring the petrochemical industry on to continued expansion. However, the wonder boy has had his ups and downs.

Certain plastic materials—notably old standbys like bakelite—have of course enjoyed steady favor for well over one or two decades. But not so with many others, though they have excellent properties and characteristics for definitely limited conditions. Problem has been in *not using them properly*. Recently, particularly in the consumer goods fields, like toys and kitchenware, some of the ill-applied plastics have fallen into tremendous disfavor—and rightly so. Toys would break soon after Junior got them from Santa; dishes would distort or crack after a few hot sudsings; spoons would catch fire easily if left on a hot kitchen range, or at least melt beyond recognition.

The signs today, however, are that specialized industry use of plastics—where they *fit the conditions* for which they were designed—may well promise new and steadier markets for the materials and, obviously, likewise for the suppliers of such raw materials as the petrochemicals.

Signs are also firm when old line metal manufacturers and fabricators get into the act. For example: about a month ago, Cooper Alloy Foundry Co., long a builder of alloys valves, fittings, pumps, etc., acquired an interest in Vanton Pump Co. Cooper now markets a product line Vanton had developed in plastic-lined pumps, valves, and accessories.

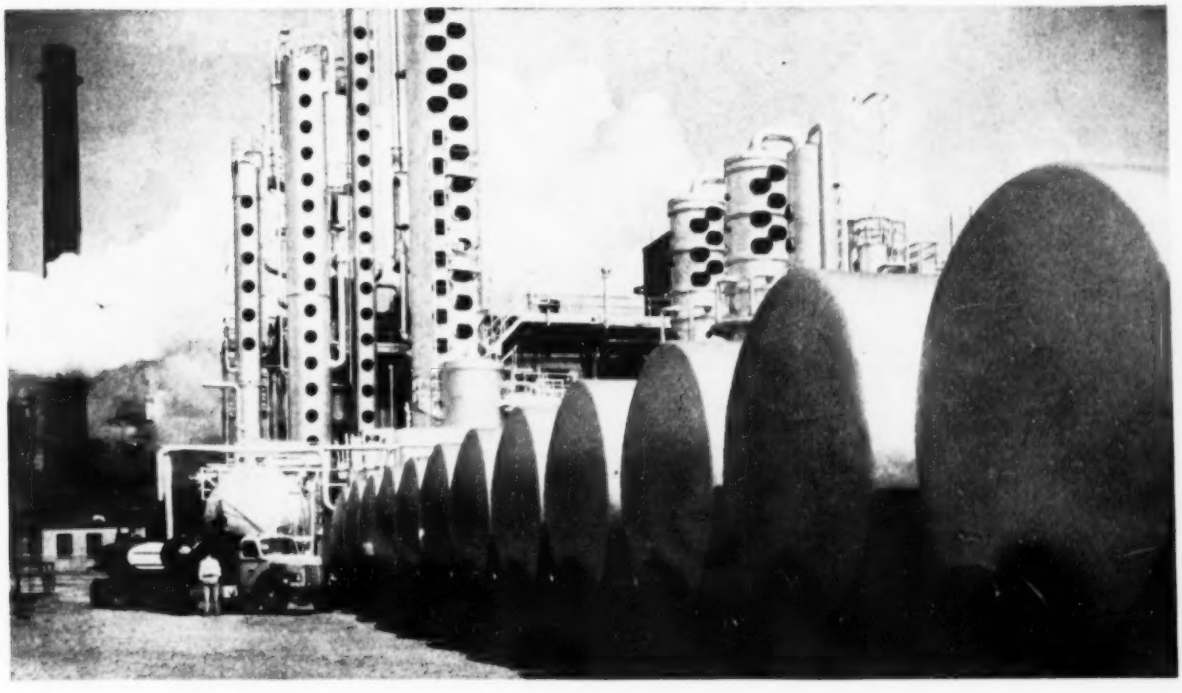
More recently, Youngstown Sheet & Tube bought into Perrault Fibercast Corp. of Tulsa, and will change the name to Fibercast Corp. and distribute its polyester-glass fiber products. Other steel firms, too, it is reported, are looking over fledgling competitors and may follow the old adage: "Iffen ye cain't lick 'em, jine 'em."

One final note: reader interest in PETROLEUM PROCESSING, as measured by use of the "What's New!" department, is definitely in high gear on all-plastic and plastic-lined pipe, tubing, fittings, valves, pumps, and the like.

—W. C. U.

TANKS PREPARED FOR ALCOHOL STORAGE BY CHEMICAL CLEANING

Dowell Service removed all traces of oil after mechanical cleaning method failed



Can you imagine cleaning out oil storage tanks so well that they could be used to store a product such as alcohol, which is so easily discolored by oil and grease?

That's exactly what Dowell did for a customer who wanted to convert three 350,000 gallon tanks from oil to alcohol storage.

Previous attempts to clean the tanks by sand blasting had not been satisfactory. And there was particular difficulty in cleaning behind the overlapping plates of one riveted tank.

Dowell Service did the job in about 10 hours per tank with this result: *the tanks were completely free from oil and grease.* Dowell furnished all trained personnel, chemical solvents, high pressure jets, pump trucks and controls.

Tank cleaning, including removal of paint from external surfaces, is just one of hundreds of applications for Dowell Service using chemicals for maintenance cleaning. For complete information and estimates on the cleaning of your equipment, call the nearest Dowell office, or write directly to Tulsa, Dept. I-32.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

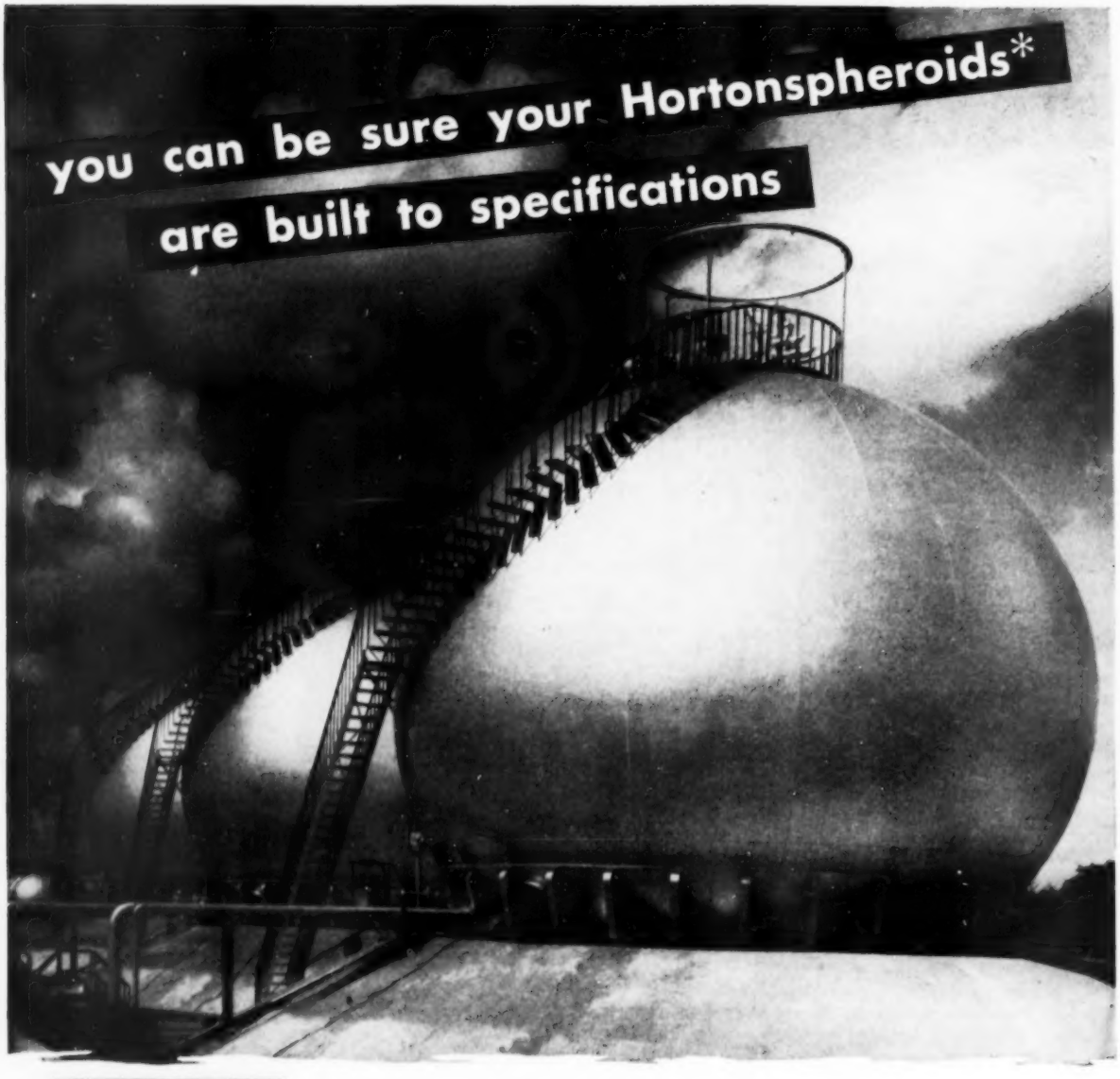
Boilers · Condensers · Heat Exchangers · Cooling Systems
Pipe Lines · Piping Systems · Gas Washers · Process Towers
Process Equipment · Evaporators · Filter Beds · Tanks

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED · TULSA 1, OKLAHOMA

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY



because . . . of the *Chicago Bridge & Iron Company Field Welding Supervisor* assigned to the job. He has supervised the cutting and grading of plugs from welds and kept a check on welding equipment and welding techniques. He has magnafluxed and x-rayed welded joints or conducted any other tests called for in the specifications. It is his job to see that the field welding is, if possible, *above and beyond* the specifications.

Complete Chicago Bridge & Iron Company Field Welding Supervision is provided on *every* tank we build at *no extra cost* to you. Write our nearest office for information, estimates or quotations on Horton tanks or any steel plate work. There is no obligation.

The three 6,000-bbl. Hortonspheroids above were built for the Shell Oil Company at Provident City, Texas. They are used to store a blend of natural gasoline and distillate at a working pressure of 35 lbs. per square inch.

Trade Mark Registered in U.S. Patent Office.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY, and GREENVILLE, PENNSYLVANIA

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Chicago 4 . . . . . 2114 McCormick Building
Cleveland 15. . . . . 2215 Midland Building
Detroit 26 . . . . . 1532 Lafayette Building
Havana. . . . . 402 Abreu Building
Houston 2 . . . . . 2130 C & I Life Building
Los Angeles 17 . . . 1526 General Petroleum Building
New York 6 . . . . . 3310-165 Broadway Building
Philadelphia 3 . . . . 1630-1700 Walnut St. Building
Pittsburgh 19 . . . . . 3236 Alcoa Building
San Francisco 4 . . . . . 1559-200 Bush Street
Seattle 1 . . . . . 1330 Henry Building
Tulsa 3 . . . . . 1620 Hunt Building

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Letters

Heavy Reflux Uses

I am interested in the article "Modernised Motor Oil Facilities" in your January, 1953 edition, particularly in the "Heavy reflux" shown in Fig. 2 page 76, which is not referred to in the text.

From Fig. 2, it appears "heavy reflux" is pumped on to tray No. 6 and withdrawn from tray No. 5 and that its make-up is obtained from tray No. 8. At the same time it appears surplus "heavy reflux" is disposed of as heavy gas oil.

I would like to know what the physical properties of this heavy gas oil are and what purposes this reflux serves. It seems probable this material serves mainly as a carrier for a neutralising agent introduced on tray No. 6 and withdrawn from tray No. 5 in order to avoid contamination of the residuum with soaps and excess alkali. If this is so I wonder if it would be possible to supply any details of this scheme or of any other similar scheme whereby the distillates can be neutralized without contaminating the residuum and without neutralisation of the separate product streams.

H. KAYE

Process Superintendent

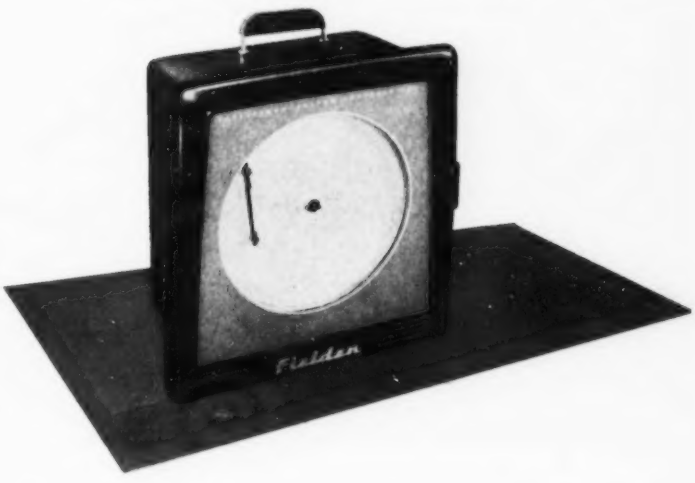
Manchester Oil Refinery Ltd.
Manchester, England

• *For an authoritative answer to reader Kaye's question, the Editors referred this letter to the author of the above mentioned article, Mr. Robert B. Selund of Standard Oil Co.'s (Ind.) research department in Whiting. Here is his reply:*

". . . The heavy reflux system has two functions: (1) to permit making a heavy motor oil distillate of narrow boiling range while controlling the softening point of the residuum; and (2) to increase liquid flow on the lower trays to reduce entrainment of asphaltic material into the motor oil fractions.

"The heavy gas oil is drawn off from either tray No. 5 or tray No. 8 and recycled as reflux to tray No. 6. The net heavy gas oil stream drawn off is dark in color from entrained asphaltic material and has a viscosity intermediate between the heavy motor oil distillate and residuum. Width of the fraction increases, of course, with increased degree of reduction of the residuum."

accurate instrumentation need not be costly



here's proof . . . Accurate to ± 1% of full scale, this Fielden TEKTOLOG Electronic Recorder has a sensitivity of ± 0.1% and reproducibility of ± 0.5%. Yet it sells at a price substantially below that of servo-operated potentiometer-type recorders!

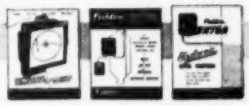
Reason: *Simplified* design, circuitry and construction. TEKTOLOG's recorder mechanism consists of only 4 principal units. By stressing *simplicity*, Fielden can bring you *all the accuracy you need* for most applications—without extra charges for marginal precision.

If simplified, practical instrumentation appeals to you, write us today for full details. There's no obligation.

DOLLAR FOR DOLLAR—YOUR BEST INSTRUMENT VALUE

Fielden

INSTRUMENT DIVISION



ROBERTSHAW-FULTON CONTROLS COMPANY
2920 N. 4th St., Dept. K, Philadelphia 33, Pa.

Send full details of Fielden simplified ☐ TEKTOLOG Electronic Recorders
☐ TELSTOR Electronic Level Indicator ☐ TEKTOR Electronic Level Control

*Name*_____

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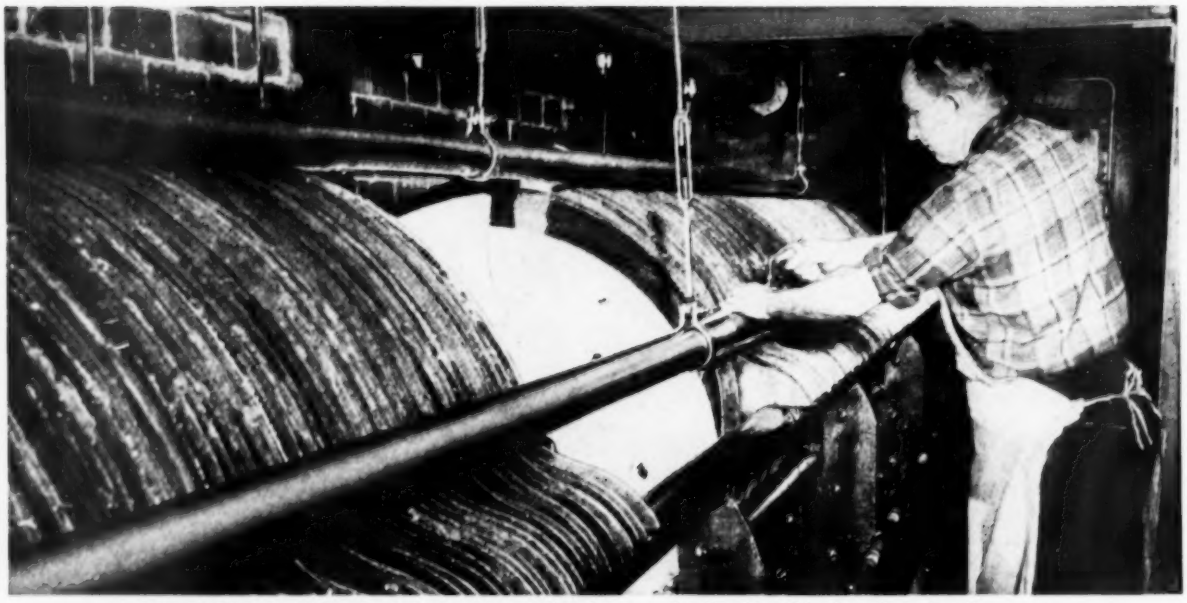
*Company*_____

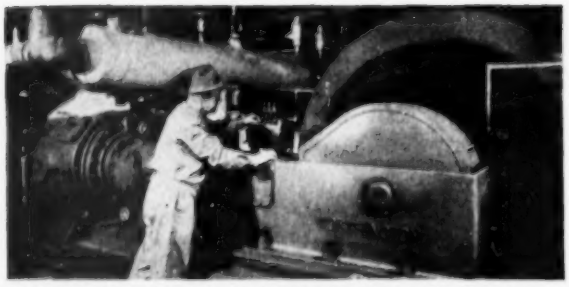
*Address*_____ *City*_____ *State*_____

 (To obtain more data on advertised products see page 1400)

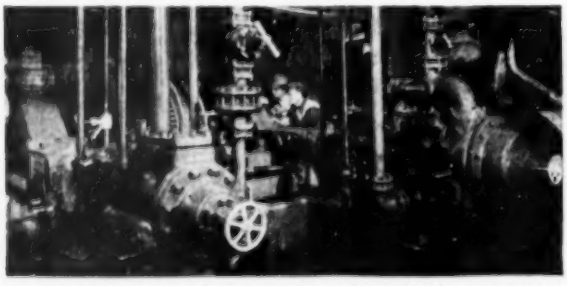


WAX PRESSES ARE STRIPPED once every twenty-four hours at the Freedom-Valvoline plant. Paraffin wastes are separated from wax distillate by chilling the distillate directly and removing the wax with a filter press.

Worthington equipment marks quarter-century at Freedom-Valvoline



WORTHINGTON REFRIGERATION EQUIPMENT at Freedom is used for dewaxing petroleum by two methods. In addition to the filter press method, wax is removed by chilling naptha solutions to precipitate the waxes and then centrifuging.



THIS WORTHINGTON AMMONIA COMPRESSOR has been operating in dewaxing service at Freedom since 1928.

Refrigeration units operate continuously in dewaxing service

Reliable, continuous operation of refrigeration equipment is a must in the processing of high-grade motor oils.

That's why the Freedom-Valvoline Oil Company has been using Worthington refrigeration equipment—ammonia compressors, boosters, brine pumps and heat exchangers—in dewaxing service at their plant in Freedom, Pa., for more than 25 years.

For more than half a century, Worthington engineered refrigeration installations have been serving leaders in industry everywhere. Today, the complete Worthington line is ready to meet any assignment, large or small. Remember, Worthington systems are all Worthington-*made*, not just Worthington-assembled. In addition to getting a perfectly balanced system, users benefit by Worthington's complete unit responsibility. Get in touch with your nearest Worthington district office, or write to Worthington Corporation, Air Conditioning and Refrigeration Division, Harrison, N. J.

A-3-58

Climate Engineers to Industry, Business and the Home

WORTHINGTON

DU PONT
REG U S PAT OFF

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT
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September ★ *One of a Series of Interest to the Petroleum Industry* ★ *1953*

100th ANNIVERSARY of Petroleum Research

The world's first scientific examination of crude oil was conducted by Dr. Crosby at Dartmouth College in 1853. The 100th Anniversary of this event was recently observed at Dr. Crosby's home, which also served as his laboratory.

Today, this event has far greater significance to the world than could possibly have been attached to it a century ago. From the first kerosine lamp to our modern synthetic fibers made from petroleum . . . from the first raucous chugging of the "horseless carriage" to jet airplanes that exceed the speed of sound—petroleum research has been a driving force in advancing our civilization.

Petroleum research itself has grown and progressed, too . . . from one man in a home laboratory to thousands of highly trained specialists in hundreds of modern oil and chemical industry laboratories. In the Du Pont Company alone—which makes many of its products out of petrochemicals and supplies the industry with petroleum additives—there are hundreds of specialists doing petroleum research work exclusively.

Mid-Continent District Manager

ROBERT M. GLOVER came to Du Pont from The Humble Oil Company in 1947. He was assigned to the Petroleum Chemicals Division's Mid-Continent District as a sales-service representative. In 1952 he became manager of this district.

ROBERT M. GLOVER

His experience in oil refining began in the Humble Oil Company's refinery at Baytown, Texas. There he did both field and research laboratory work. In the laboratory, he worked on solvent extraction of lubricating oils and the refining of petroleum waxes.

In 1940 he was transferred to Humble's products inspection laboratory where he directed the testing and loading of finished petroleum products into tankers, barges and tank cars.

Enlisting in the Navy in 1941, Glover was assigned to the office of the Inspector of Naval Materiel. There he supervised the acceptance of petroleum products bought by the U.S. Navy. After his discharge from the Navy in 1946, he returned to the Humble Oil Company as a product inspector.

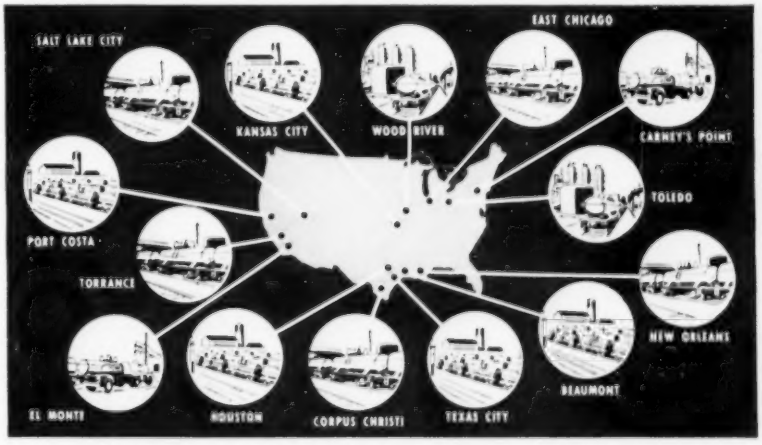
Mr. Glover received a B.S. degree in chemical engineering from Rice Institute and completed an additional year of graduate study at Massachusetts Institute of Technology.

You can count on Du Pont's 14 TEL STORAGE AREAS to Serve You in any Emergency

Strategically located rail sidings and truck facilities mean that "rush" TEL shipments can reach you in a matter of HOURS

You can now be assured of an ample supply of tetraethyl lead to meet any emergency, at any time.

To make this possible, Du Pont's Petroleum Chemicals Division maintains 14 rail sidings and tank truck terminals conveniently located adjacent to the major refining areas. And they are kept fully stocked with loaded TEL tank cars . . . ready to roll to any refinery at a moment's notice.



LOCATED near all the major refining areas, these 14 Du Pont shipping points are prepared to fill orders for TEL at any time of the day or night.

IN CASE OF EMERGENCY . . .

This extensive Du Pont distribution network was set up to help refiners meet emergency requirements for TEL which might not have been anticipated in regular delivery schedules . . . or to replace shipments which might have been held up by floods, train wrecks, strikes or other unforeseen circumstances.

NATIONWIDE SET-UP

Rapid delivery facilities are located at the following strategic points: Port Costa (San Francisco),

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED

Rapid Deliveries

Torrance and El Monte, California; Houston, Corpus Christi, Texas City and Beaumont, Texas; Salt Lake City, Utah; Kansas City, Missouri; Wood River, Illinois; East Chicago, Indiana; Toledo, Ohio; New Orleans, Louisiana; and Carney's Point, New Jersey.

The tank truck terminals at Carney's Point, N. J. and El Monte, Calif. are complete with weigh tanks and storage facilities. These make it possible for refiners to receive rush shipments of TEL in smaller-than-tank car lots.

FULLY LOADED, this TEL tank car is ready to roll to a refinery from a nearby siding on a moment's notice.

'ROUND-THE-CLOCK SERVICE

An ample supply of both Motor Mix and Aviation Mix is always on hand at all 14 shipping points. And there is someone at the phone to expedite your order at any time of the day or night. What's more, the chances are that your rush orders can be filled in a matter of a few hours—depending on the distance to your refinery.

FULLY STOCKED WAREHOUSES

In addition to the mobile units handling tetraethyl lead, Du Pont also maintains three fully-stocked warehouses in Houston, Los Angeles and Wilmington, Delaware, which carry a large supply of all other Du Pont petroleum additives.

FOR CONVENIENCE, smaller-than-tank car shipments of TEL can be sped to refineries by tank truck from El Monte, California and Carney's Point, New Jersey.

Field Tests Show Effectiveness of Du Pont Fuel Oil Additive No. 2

The following test, conducted by a major oil company, shows how you can reduce filter screen clogging in domestic oil burners with the new Du Pont Fuel Oil Additive No. 2.

The test was conducted under actual operating conditions during the 1951-52 heating season. The fuel used was of uncertain age and had been transported by tanker to a water terminal before the Fuel Oil Additive No. 2 was added. The fuel itself was a blend of cat-cracked and straight-run stocks having the following properties: 0.21% S; 326° F. – I.B.P.; 598° F. – 90%; 654° F. – E.P.

Approximately 70,000 barrels of this fuel were treated at a concentration of 30 pounds per 1,000 barrels during the loading of barges from shore tanks at the water terminal. The treated fuel was then delivered to another water terminal storage tank – from which it was supplied to all of the customers served by this terminal.

None of the customer burner units used in the test were given any special cleaning or reconditioning beyond the normal routine servicing. The test was continued throughout the heating season.

For a control, a similar marketing area was supplied with the same fuel—without the addition of Fuel Oil Additive No. 2.

Typical results of this test are shown in the above photograph. This shows filters used in a commercial burner consuming about 1800 gallons per month. Prior to the start of the test, this burner had required filter replacement each month. But when Du Pont Fuel Oil Additive No. 2 was added to the fuel, the filter was unusually clean and serviceable after a 10,800 gallon thruput.

LITERATURE AVAILABLE

Here is a partial listing of the bulletins, reports, booklets, movies and aids available to you through any Du Pont Petroleum Chemicals Division district office:

The Service Station and the Motorist – Report Nos. 1, 2 and 3 are now ready for distribution. Authoritative studies on gasoline buying habits in regard to service station loyalty, brand name loyalty and gasoline grade selection . . . . . Serials A-5396, A-5347 and A-5826

Du Pont Fuel Oil Additive No. 2—A 12-page bulletin describing this ashless stabilizer and dispersant which prevents clogging of fuel oil screens . . . . . Serial A-5201

Pipeline on Wheels—A 26-minute, full-color movie on tank truck safety. Suitable for both training and public relations purposes.

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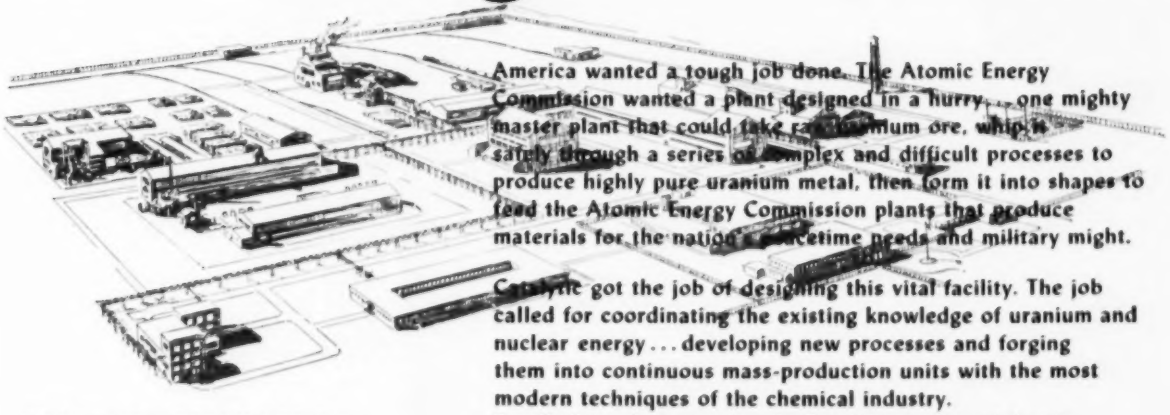
A-5949

Printed in U. S. A.

CATALYTIC CONSTRUCTION 100% ON TIME

CATALYTIC MEETS

the Challenge of Uranium-



Artist's conception of Feed Materials Production Center at Fernald, Ohio, whose initial operations were announced by the Atomic Energy Commission on May 15, 1953.

America wanted a tough job done. The Atomic Energy Commission wanted a plant designed in a hurry... one mighty master plant that could take raw uranium ore, whip it safely through a series of complex and difficult processes to produce highly pure uranium metal, then form it into shapes to feed the Atomic Energy Commission plants that produce materials for the nation's peacetime needs and military might.

Catalytic got the job of designing this vital facility. The job called for coordinating the existing knowledge of uranium and nuclear energy... developing new processes and forging them into continuous mass-production units with the most modern techniques of the chemical industry.
It called for designing hundreds of items of special and novel equipment not available on the open market.

Catalytic met the challenge of time and skill and designed the 1050-acre, seventy-eight million dollar Feed Materials Production Center at Fernald, Ohio. Automatic remote-control equipment processes the uranium materials through the intermediate chain of products... UO_3... UF_4... and finally to metal ingots, rods and slugs which are the working material for atomic energy plants. Recovery of expensive chemicals and valuable scrap materials was an important part of Catalytic's job.

Research and Development • Process Design
Pilot Plant Investigations • Engineering • Economic Studies
Procurement • Construction • Plant Operation
Revamp of Existing Facilities • Plant Maintenance

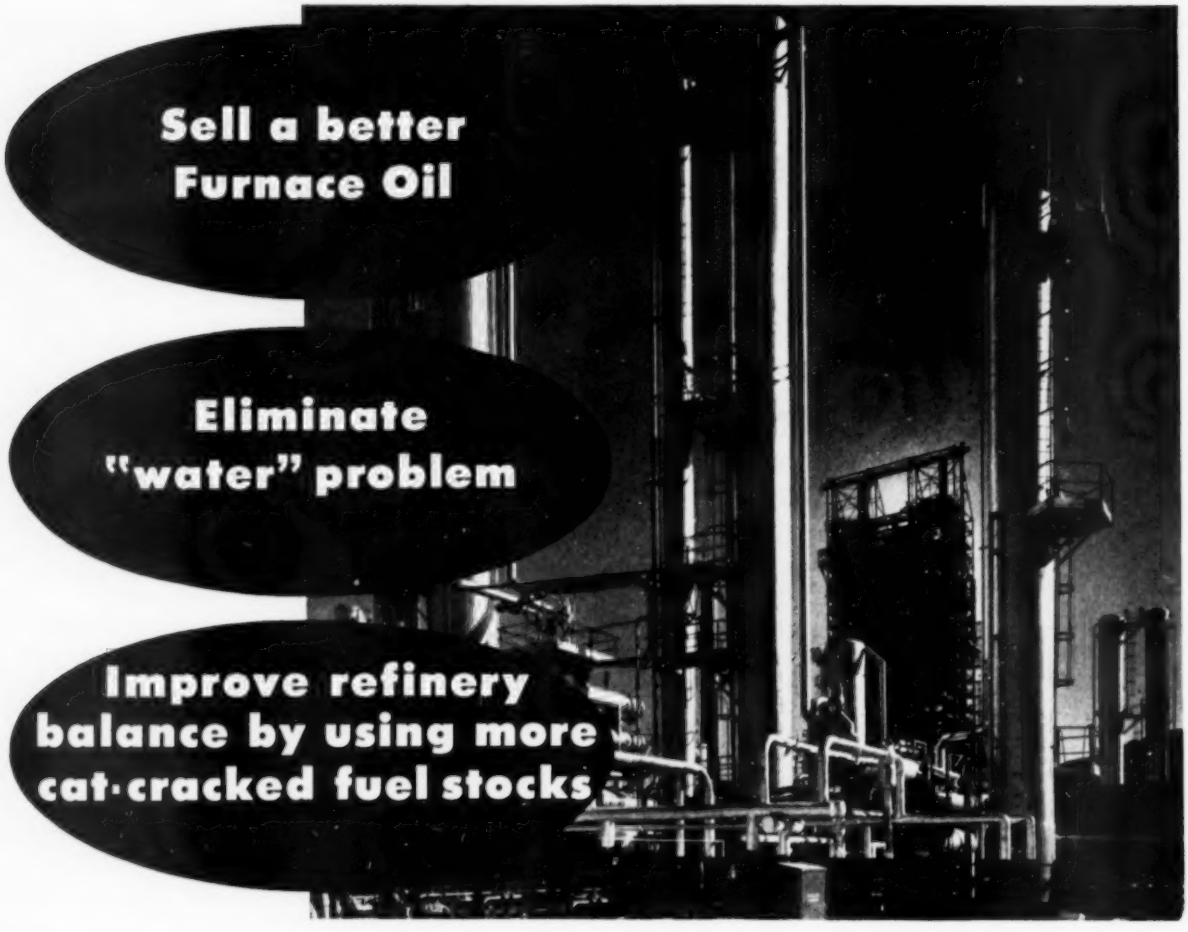
CATALYTIC

CONSTRUCTION COMPANY

1528 Walnut Street, Philadelphia 2, Pennsylvania

In Canada:
Catalytic Construction of Canada, Limited: Sarnia, Ontario

With NEW Dispersant FO



Dispersant FO is a new anti-gumming, rust-inhibiting additive that greatly reduces, even eliminates, deposits and screen clogging in home heating units and storage tanks. Your product with FO will offer dealers many competitive advantages and greatly reduce their number of costly service calls due to clogged filter screens and nozzles.

"Water" is always *the big problem* for the distributor, dealer and home user. The active ingredient in FO is an entirely new chemical, developed especially for use in furnace oils. NEW DISPERSANT FO DOES NOT EMULSIFY WATER WITH BURNER OIL. It will settle the water out of burner oils in short order to provide a "dry" fuel.

Furnace oil with FO has exceptional rust-proofing properties. Steel and iron surfaces in contact with the oil are made corrosion resistant.

This new additive improves stability and permits the blending of higher percentages of cat-cracked stocks without additional gum formation. It improves refinery balance, and you can cut costs by reducing the severity of acid treating of your cat-cracked heating stocks.

The stabilizing action and rust-inhibiting quality of Dispersant FO are obtained at very low dosages. Usually added in the ratio of 1 pint per 1000 gallons of oil stock, at any temperature, prior to shipment by tanker, pipe line or truck.

For complete product data and samples, write or phone the nearest Oronite office.

ORONITE CHEMICAL COMPANY

38 SANSOME STREET, SAN FRANCISCO 4, CALIFORNIA
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THE NAME TO WATCH IN CHEMICALS

a new miniature indicator!

Available with:

MEASURED VARIABLE → AIR-PILOT → COPPER TUBING

PNEUMATIC TRANSMISSION

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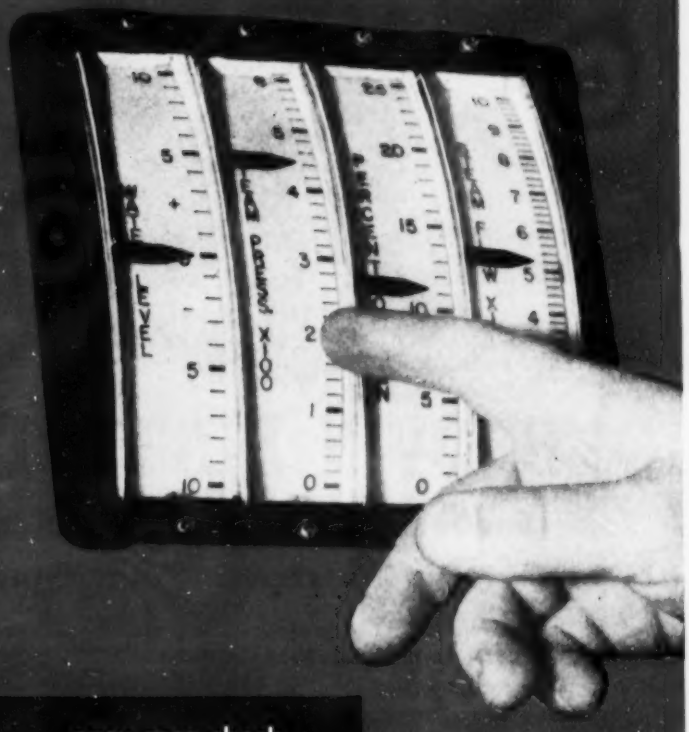

removable units—interior illumination

easy to read—5 inch scale, no parallax

easy correlation of related functions

easy zero check from the front

HAYS Miniature Indicators

This miniature instrument is especially suited for remote indication of such variables as pressure, draft, flow or level.

The scale is only 5 inches long — easy to read — internally illuminated. Choice of pneumatic or electric transmission.

Also available is the Hays direct reading miniature gage for indicating *pressures* of fluids (steam, water, gas, oil, etc.) directly.

Gages are arranged for flush or semi-flush mounting. Either a yoke mounting, for as many as 12 units, or a keyhole clamp mounting for individual units can be provided.

Write today for full information on the Hays Miniature Indicator Bulletin 52-1075-223.

Automatic Combustion Control
Boiler Panels • Hays Penn Flowmeters
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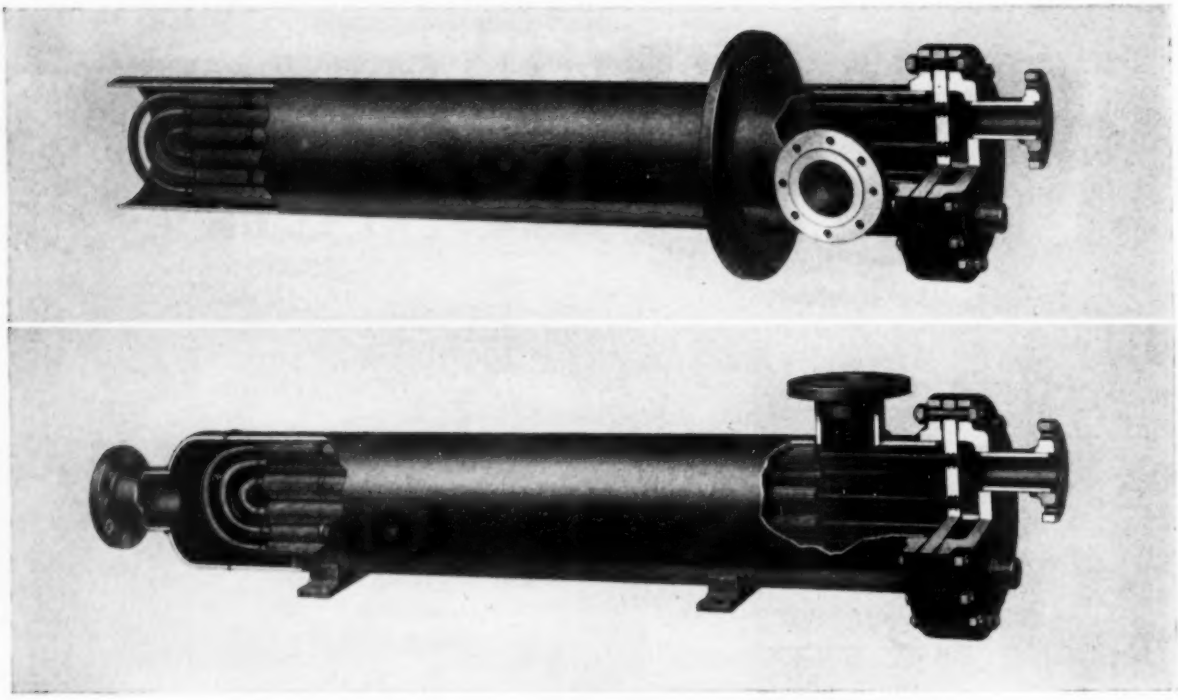


BROWN FINTUBE

Tank Suction Heaters and Line Heaters

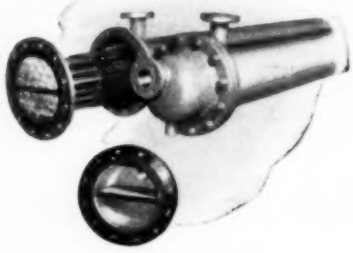
Offer Many Outstanding Advantages

Brown welded fintubes provide much greater heating surface per foot of length than plain bare pipe or tubing. Consequently these heaters transfer more heat — at lower temperatures — assuring **faster, more efficient** heating without damaging the material or causing coking and build-up on the heating surface.

Metal bands placed around alternate fintubes in the bundle prevent the tubes from interlocking. This eliminates baffles and tube spacers that create back eddies and stagnant areas that encourage fouling;—and permits the fluid to travel through the longitudinal passages of the fintubes in close contact with the fins and center tubes — at low pressure drop.

Tank Suction Heaters that mount on a tank nozzle or the tank shell — also Line Heaters for pressure or suction service. Sizes 5″ to 24″ in diameter and 4′ to 24′ in length. Send for Bulletin No. 521. It gives full details.

Brown Fintube Hairpin Bundles Showing the Banding of Alternate Tubes that Eliminates Baffles and Assures Unobstructed Flow.



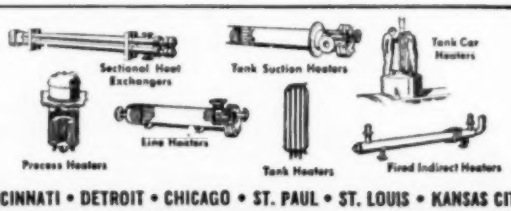
Hairpin Bundle Assembled in Shell Showing Mounting of Tube Sheet Between the Shell and Head.

BROWN FINTUBE

HEAT TRANSFER PRODUCTS

BROWN FINTUBE CO.

Elyria, Ohio



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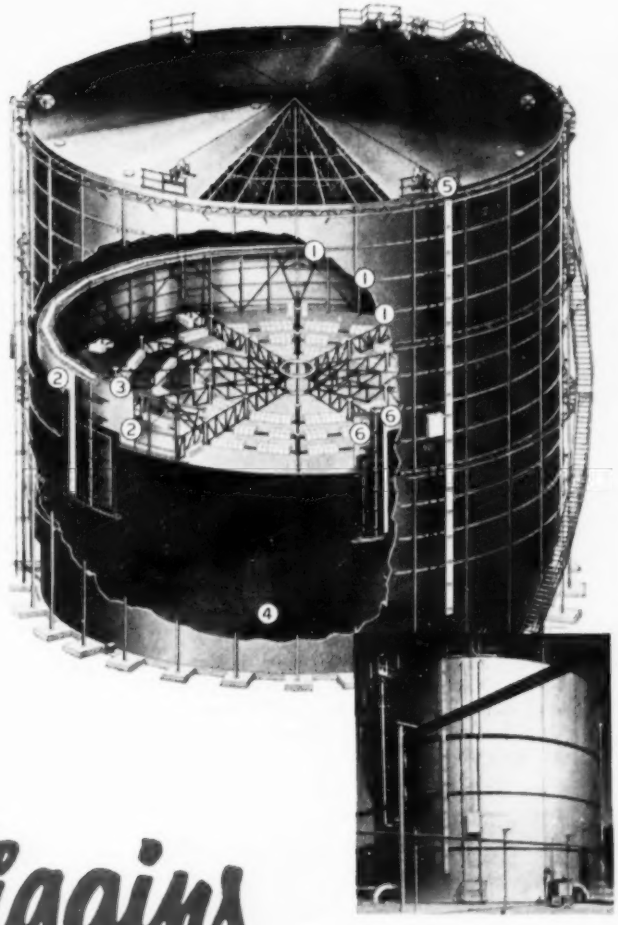
GUIDES TO GASHOLDER PLANNING

no. **1** *of a series*

"Will our gasholder be efficient? Safe? And . . .



1 Top section of shell completely ventilated

2 Wide clearances simplify operation

3 Gas-tight friction-less seal not affected by weather

4 Piston rests on bottom—less than ½ of 1% for purging

5 Leveling device—independent of side-wall—keeps piston level

6 Fenders prevent all tension in seal

How much does maintenance cost?"

Recently one of our engineers asked the chief engineer of a large corporation, "What are maintenance costs on your Wiggins gasholders?"

"Maintenance—what maintenance?" was the answer. "Since they were installed a year ago, no one's had to *look* at our Wiggins gasholders! What used to be maintenance expense now goes into profit!"

Wiggins' engineers get the same answer at practically every installation they visit: no operating costs, little or no maintenance costs.

Reason: the Wiggins' patented *dry* seal is permanent, impermeable and weatherproof . . . flexible, yet strong as steel. No need for constant checking on toxic or explosive gas accumulations. No anti-freeze or evaporation worries as with liquid seals. No complex rigging to corrode or get out of order. For complete facts, write General American.

Wiggins Gasholder

GENERAL AMERICAN TRANSPORTATION CORPORATION

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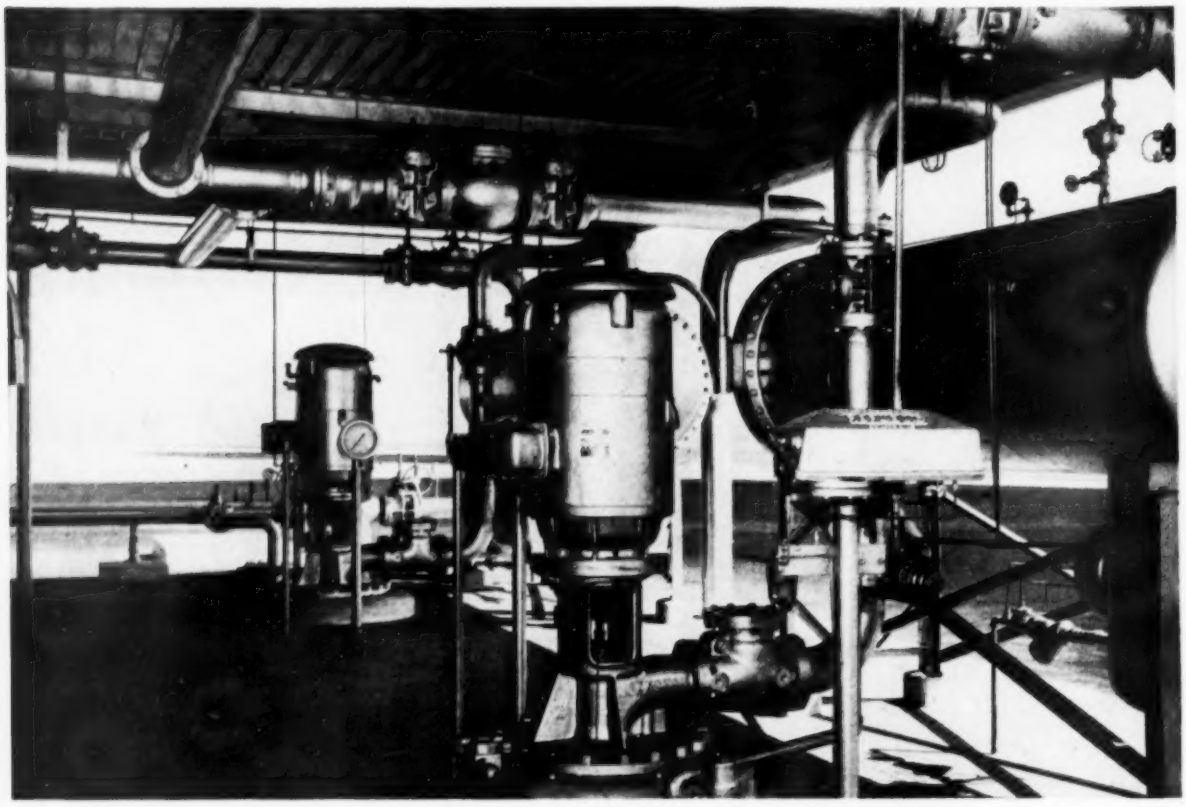
Tough-to-handle liquids are routine for Johnston



TAKE VOLATILE FLUIDS, FOR EXAMPLE

Illustrated are two of forty Johnston Volatile Fluid Pumps installed at a major California airport. These units, used for refueling aircraft, were selected for this job for MANY reasons . . . Here is just ONE —

Steep Head-Capacity Characteristic

This characteristic allows a greater margin of safety in the selection of a pump to meet design head or discharge pressure conditions. Thus, the design engineer provided for the maximum head condition without the resultant expense of an oversize horizontal pump necessary to prevent serious loss of capacity in case head conditions might be underestimated, or to allow a margin for eventual increase of friction loss as piping ages. The Johnston Vertical Turbine Pump, with its flat horsepower requirement and steep head-capacity curve, will not be backed off the line by increasing heads, nor overloaded at reduced heads.

This is another typical example of the ability of Johnston equipment to handle all types of pumping jobs in large or small operations. Why not let our trained engineering staff consult with you on the best solution to YOUR particular problem?

Send today for your free copy of our new bulletin VERTICAL PUMPS FOR VOLATILE FLUIDS. *Ask for Bulletin* P-93.

JOHNSTON VERTICAL PUMPS

JOHNSTON PUMP COMPANY

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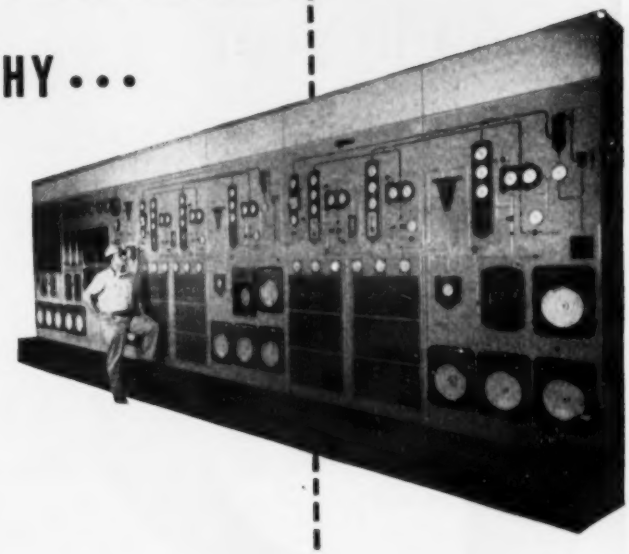
6 REASONS WHY...

PANELLIT is the largest builder of process control panels



1 **SPECIALIZED ENGINEERING** . . combining instrumentation and process experience, PANELLIT provides sound and economical engineering as a part of their service.

2 **ADVANCED STANDARDS OF CONSTRUCTION** . . . have distinguished PANELLIT in every detail of structure, finish, piping, terminal arrangements and serviceable behind-the-panel layouts.

3 **PIONEERING CONCEPTS OF INSTRUMENTATION** . . . the graphic control panel, miniature instrumentation, unitized annunciator systems, scanning and monitoring devices . . . all have been closely associated with PANELLIT.

4 **ORGANIZATIONAL FLEXIBILITY** . . . Few process control panels are ever shipped without changes. When "change orders" are received, PANELLIT moves quickly to carry them out . . . without confusion . . . without delay. Where others take weeks, PANELLIT takes hours.

5 **THE ONE MAN PLAN** . . . makes PANELLIT easy to work with. One project engineer stays with your job. There are no "pass along instructions" or "round about authority".

6 **INFORMATION SYSTEMS** . . . an advanced PANELLIT concept of the control panel has resulted in better process control. An *information system* filters information for the operator to know . . . and presents it in a manner that he may act quickly and instinctively. *Write for complete information.*

PANELLIT

INFORMATION SYSTEMS

PANELLIT, INC., 6312 N. BROADWAY

CHICAGO 40, ILLINOIS

Fill your chemical processing

with Norton SPECIAL Refractories engineered to your needs

To improve chemical processes or increase yields, get your answer from Norton.

No *one* refractory can be the solution to all your problems. But Norton Rx service will help you get the composition best suited to your particular purpose.

In almost every field of chemical processing, Norton Refractories are making definite contributions — improving methods and cutting costs. This is true in catalyst supports for the manufacture of phthalic anhydride, for reforming natural gas and production of "atmosphere gas" — electric furnace shapes . . . porous mediums, for filtration, diffusion and aeration.

To get your Rx in catalyst supports

Norton makes catalyst supports having *controlled* structure. Thus the Rx for rings and pellets can range from medium porosity to high porosity — for spheres from medium porosity with rough exterior for coating with a catalyst, to high porosity with a network of open pores throughout and rough exterior designed for impregnating with catalyst. Spheres are made in diameters ¼″ to 1″. Rings supplied from 3/32″ I.D., 3/16″ long, 7/32″ O.D. to ½″ I.D., 1″ long, 1″ O.D. Pellets from ⅛″ x ⅛″ to ½″ x ½″. Catalyst supports are just an example of Rx engineering.

The "Basic 4" for your Rx

According to the requirement your Rx is for ALUNDUM*, CRYSTOLON*, MAGNORITE*, or FUSED STABILIZED ZIRCONIA, each with its own particular characteristics. All are chemically stable . . . all are highly refractory, resistant to abrasion and have extra long life. Here are just a few of their uses in many fields.

***Norton ALUNDUM* catalyst supports in the manufacture of phthalic anhydride, production of "atmosphere gas" and in reforming natural gas.**

***Norton FUSED STABILIZED ZIRCONIA* has stood up under 4700°F in gas synthesis. Its low thermal conductivity and its high electrical conductivity at elevated temperatures make it useful for many special chemical processes. No other refractory is so chemically stable under high temperature.**

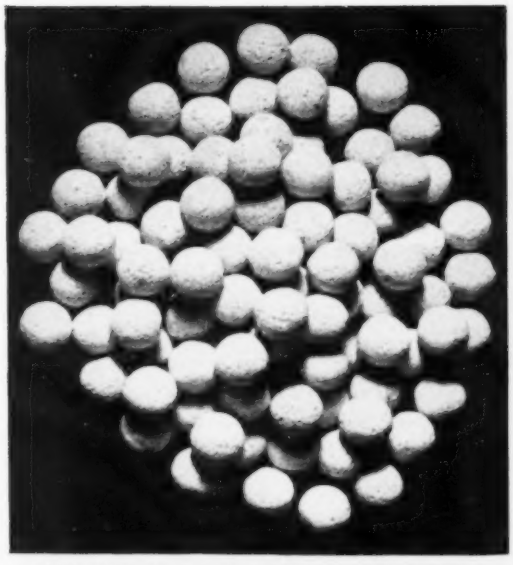
***Norton ALUNDUM* porous mediums with "controlled permeability" are ideal for filtration, diffusion or aeration.**

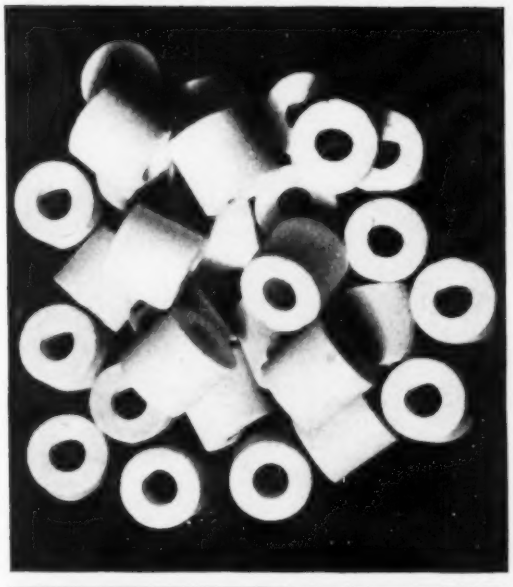
***Norton ALUNDUM, CRYSTOLON and MAGNORITE* mixtures for reaction furnaces are supplied in a variety of shapes engineered to your exact requirements.**

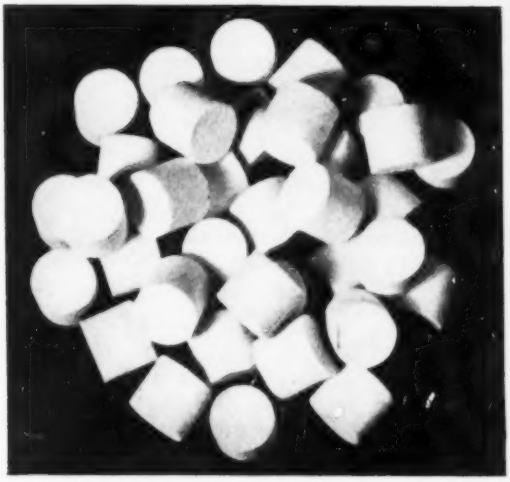
Find out more

So broad is Norton's range of Special Refractories that it can only be outlined here. We believe that it will pay you to make Norton Refractory Research your partner in solving your problems. For quick action, just contact your Norton Refractories Representative or write NORTON COMPANY, 268 New Bond St., Worcester 6, Mass.

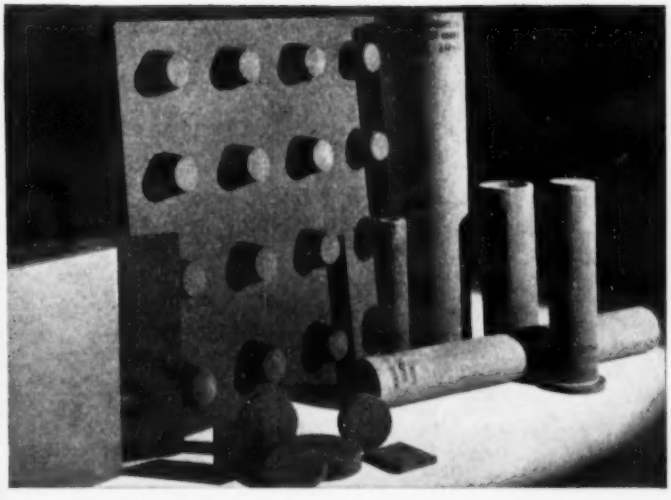
(To obtain more data on advertised products see page 1400)



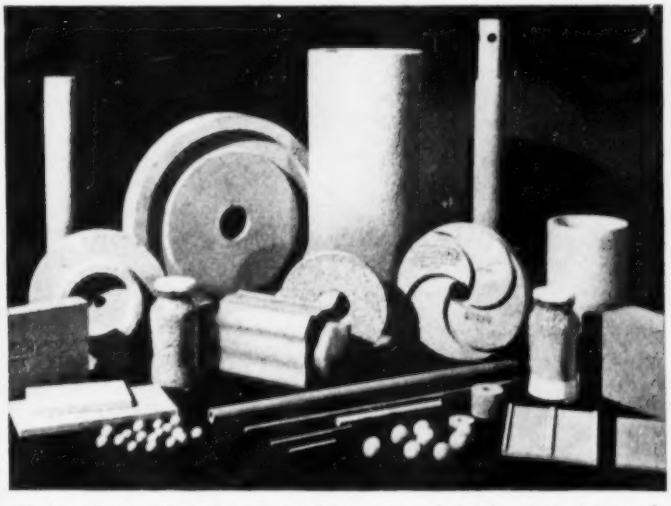




Norton catalyst supports are made in spheres, pellets and rings, by Norton's "controlled structure" process.



Norton ALUNDUM porous mediums come in plates, tubes, discs and diaphragms to fit your exact requirements.



Norton refractory shapes for reaction furnaces come in bricks, plates, tubes and blocks of ALUNDUM, CRYSTOLON, MAGNORITE and FUSED STABILIZED ZIRCONIA.

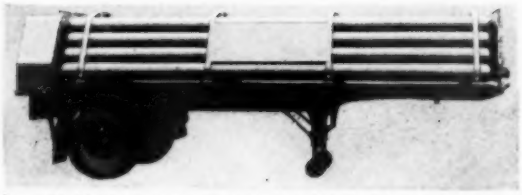
Special REFRACTORIES

Making better products to make other products better

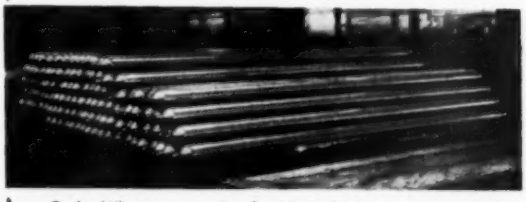
*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

 (*To obtain more data on advertised products see page* 1400)

NEW hydrogen transport solves refiners' storage problems



Semi-trailer with 30 or 38 tubes is delivered to point of usage. Capacity of 30 tube unit is 39,000 cu. ft. at 2400 psi; of 38 tube unit, 50,000 cu. ft. at 2400 psi.



Taylor-Wharton can also furnish individual storage cylinders, made to ICC 3A2400 classification and qualifying under API-ASME for 1450 psi.

Semi-trailer Mounts 30 or 38 Tubes for Mobile, Compact, High Pressure Hydrogen Storage

In response to hydrogen storage problems faced by new platforming process plants, Taylor-Wharton offers two kinds of high pressure cylinder installations, the permanent and the transport, now successfully used in the chemical industry.

Investigation of high pressure equipment will reveal the economy of this method of storage. (Low pressure storage requires an expensive compressor.) The tubes readily provide a flexible supply of hydrogen to get you "on stream" quickly. High pressure storage saves space, packing up to 50,000 cubic feet of hydrogen at 2400 psi in the transport.

Write now for Bulletin 300 which will show you the economy of Taylor-Wharton cylinders for your hydrogen plant.

Taylor-Wharton high pressure transports efficiently store and deliver for Allied Chemical & Dye Corporation. High storage capacity and mobility will save handling dollars and floor storage space for you too.

Modern heat treating facilities for tubes at Taylor-Wharton Iron and Steel Company.

ESTABLISHED IN 1742 TW

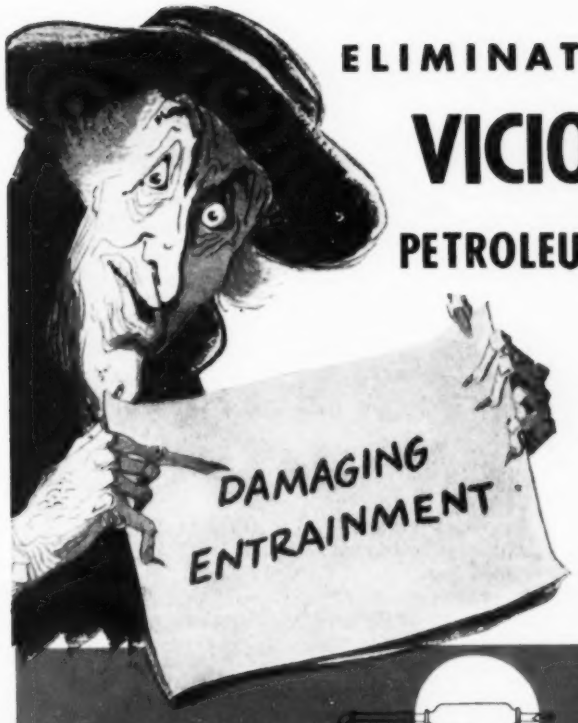
TAYLOR-WHARTON IRON & STEEL COMPANY

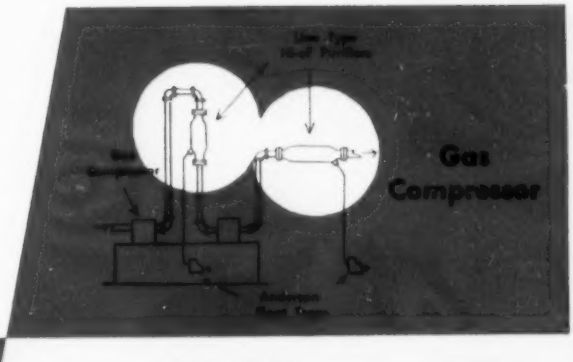
CINCINNATI 12, OHIO

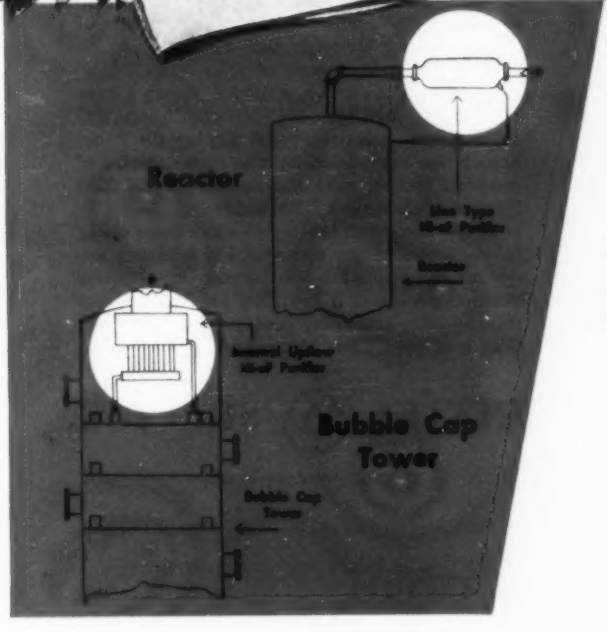
Also Manufacturers of: Manganese Steel Castings, Alloy and Carbon Steel Castings, Special Trackwork, Gas Cylinders

ELIMINATE THESE

VICIOUS ENEMIES of your PETROLEUM EQUIPMENT and PROCESSES



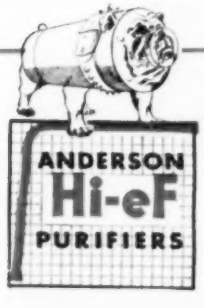




with **Hi-eF PURIFIERS**

● Mist, moisture, solid particles and carryover can be as vicious an enemy as your petroleum equipment and processes have ever seen. This damaging entrainment can cause havoc in steam systems, add to the cost of operating towers and columns, damage compressors, contaminate processes and equipment. Hi-eF Purifiers keep these costly troublemakers from raising havoc with your petroleum processes. These filterless units embody a new design of centrifugal separation that results in a new high in purification efficiency. Hi-eF Purifiers quickly pay for themselves in boilers, steam lines, bubble cap towers, compressors, reactors, vacuum towers, stripping columns and the like. Mail coupon for further details today.

WATCHDOGS OF STEAM • AIR • GAS • VAPOR PIPELINES AND EQUIPMENT



UPFLOW INTERNAL PURIFIER

LARGE LINE TYPE PURIFIER

DOWNFLOW INTERNAL PURIFIER

RECEIVER TYPE PURIFIER

THE V. D. **ANDERSON** COMPANY

1974 West 96th Street • Cleveland 2, Ohio

Please send me a copy of Bulletins describing your purifiers for the petroleum industry.

Name ..... Title .....

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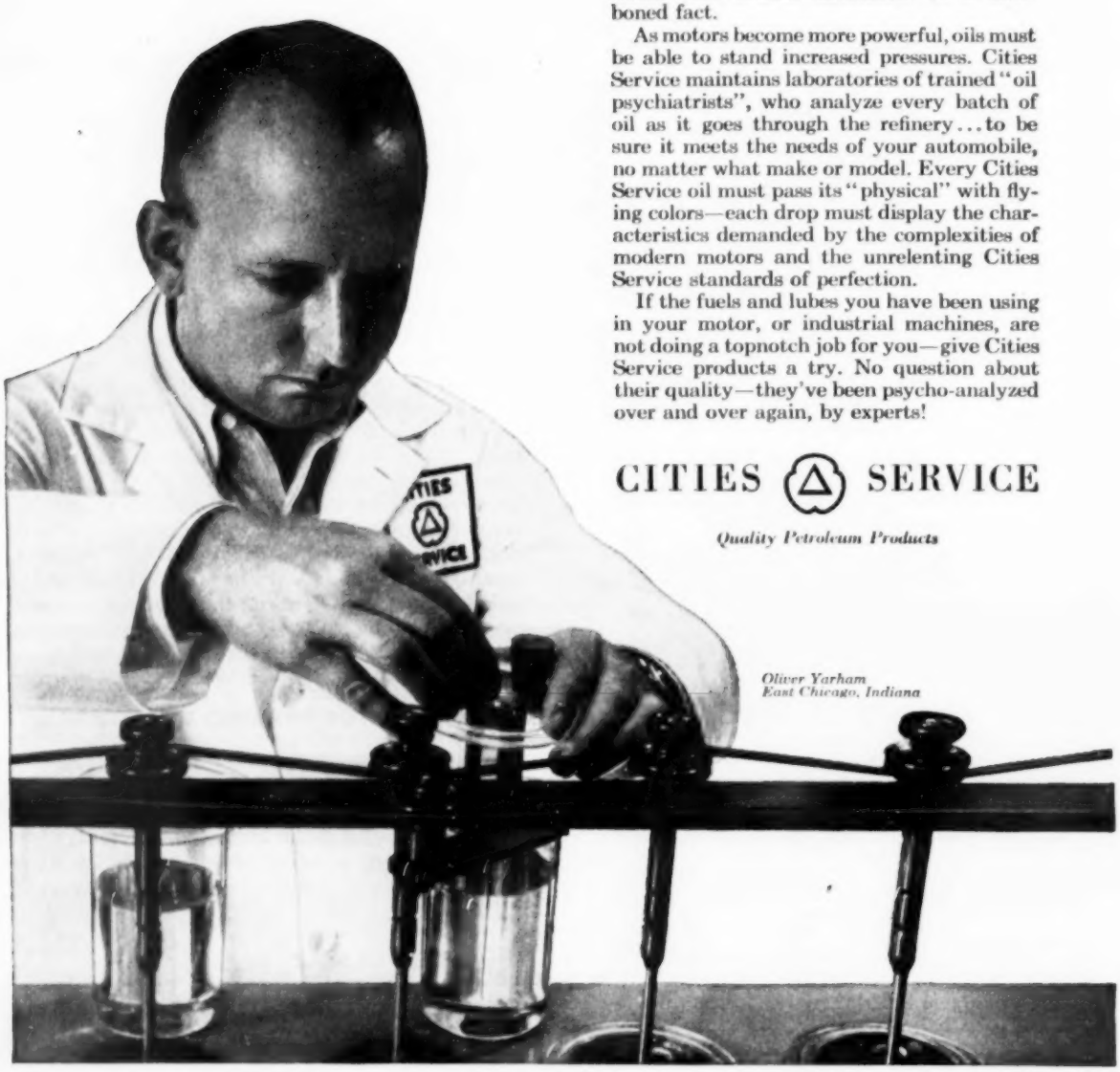
BY THE MAKERS OF SUPER-SILVERTOP STEAM TRAPS

oil goes to a psychiatrist



EVEN OIL NEEDS a psychiatrist these days. Think that sounds farfetched? It is bare-boned fact.

As motors become more powerful, oils must be able to stand increased pressures. Cities Service maintains laboratories of trained "oil psychiatrists", who analyze every batch of oil as it goes through the refinery... to be sure it meets the needs of your automobile, no matter what make or model. Every Cities Service oil must pass its "physical" with flying colors—each drop must display the characteristics demanded by the complexities of modern motors and the unrelenting Cities Service standards of perfection.

If the fuels and lubes you have been using in your motor, or industrial machines, are not doing a topnotch job for you—give Cities Service products a try. No question about their quality—they've been psycho-analyzed over and over again, by experts!

CITIES SERVICE

Quality Petroleum Products

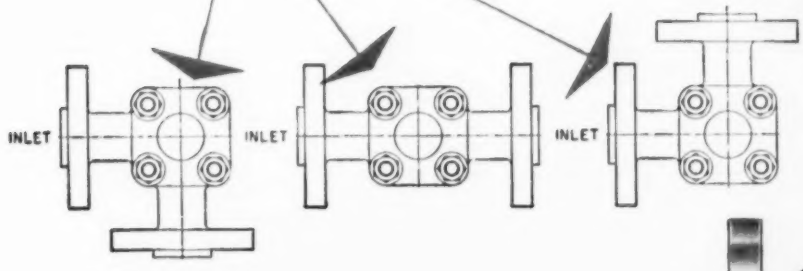
Oliver Yarham
East Chicago, Indiana

FISHER®

DIAPHRAGM MOTOR VALVE

WITH Z BODY

CAN BE EASILY CONVERTED TO OFFSET ANGLE BODY



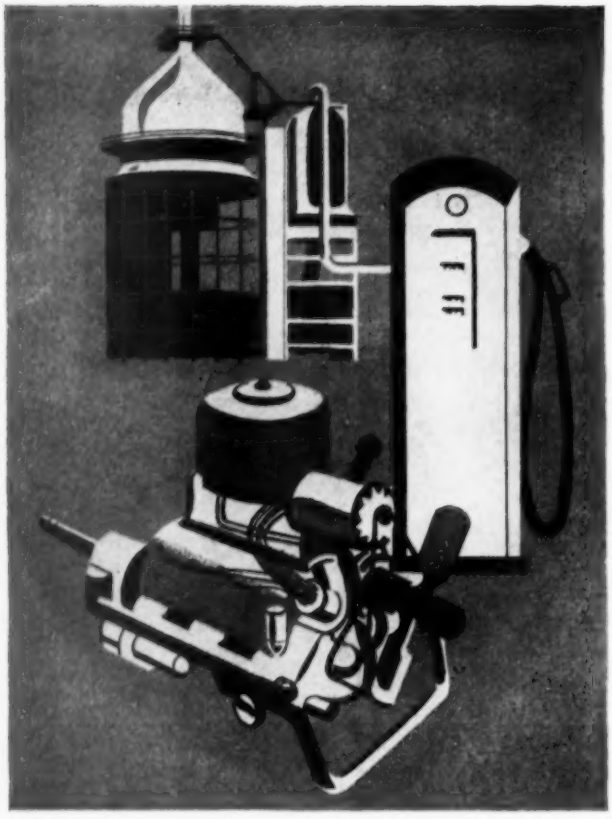
TYPE 547Z
with REVERSE ACTING TOPWORKS

- Split flange construction with seat ring retained in center without threads.
- Inner Valve—Micro-Flute, Micro-Form or throttle plug type inner valve with solid stem connections.
- Sizes ½", ¾", 1", 1½" and 2".
- Materials: Regularly furnished in carbon steel or 18-8 stainless. Also available in bronze, Hastelloy and monel other alloys on request.
- Standard ISA face to face dimensions—flanged only.
- Available with a direct or reverse acting diaphragm motor.

FISHER LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE CONTROL

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

FISHER Since 1880



Need Octane?

REFINERS NO LONGER NEED TO BUY THE HIGHEST PRICED CRACKING CATALYST TO GET THE MAXIMUM OCTANE IN CAT-CRACKED GASOLINE. WITH FILTROL SR CATALYST, THE F-1 CLEAR OCTANES EQUAL OR BETTER THOSE PRODUCED BY ANY COMMERCIAL CATALYST AT ANY PRICE.

TYPICAL COMPARISONS ON C_5—400° F. ARE SHOWN BELOW:

CATALYST	FILTROL SR		SYNTHETIC SILICA-ALUMINA	
CRUDE	TCC EAST TEXAS	FLUID MID-EAST	TCC EAST TEXAS	FLUID MID-EAST
CONVERSION	56	55.5	56	55.5
OCT. NO.				
F-1 CLR.	92.6	91.9	91.8	92.0
R.V.P.	6.3	6.7	6.4	6.8

OTHER REASONS FOR USING FILTROL CATALYSTS

1. Lowered excess butane
2. High butylene yield
3. Low cost
4. Sulphur resistant catalysts
5. Faster regeneration rate
6. Varied plant facilities
7. Uniformity
8. Technical assistance
9. Low attrition rate

Filtrol*

FILTROL CORPORATION

OFFICES: 727 WEST SEVENTH ST., LOS ANGELES 17, CALIFORNIA
PLANTS: VERNON, CALIF.; SALT LAKE CITY, UTAH; JACKSON, MISS.

CATALYSTS AND ADSORBENTS

*T. M. REG. U. S. PAT. OFF.

To be completely satisfactory, a valve must function perfectly, give maximum length of service and require minimum maintenance. To do this it has to be exactly right—in design and materials—for all the conditions under which it must operate. And because Powell makes just such a valve for every service in modern industry, Powell Valves always give complete satisfaction.

The Wm. Powell Co., Cincinnati 22, Ohio

Fig. 1793—125-pound Iron Body Bronze Mounted Gate Valve with tapered solid wedge. Made in sizes 2" to 30", inclusive.

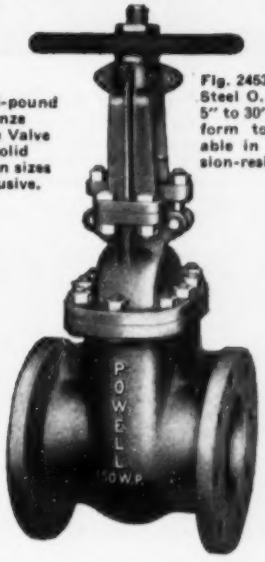


Fig. 2453-G — 150-pound Stainless Steel O. S. & Y. Gate Valve. Sizes 5" to 30", incl. All dimensions conform to latest standards. Available in a variety of other corrosion-resisting metals and alloys.

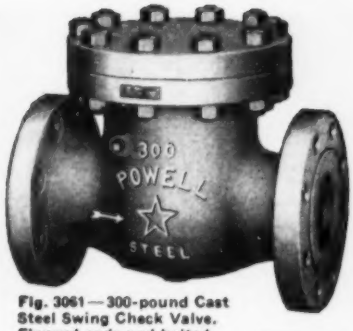


Fig. 3061—300-pound Cast Steel Swing Check Valve. Flanged ends and bolted cap. Disc has ample lift to permit full, straightway, unobstructed flow through the valve body.

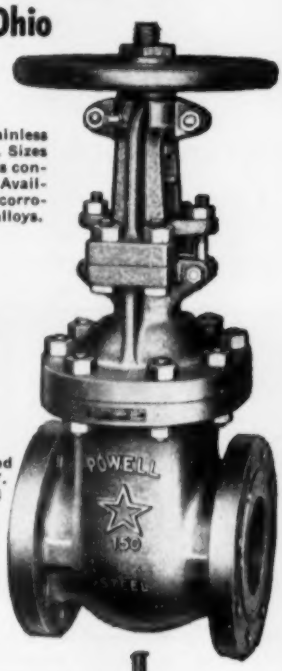
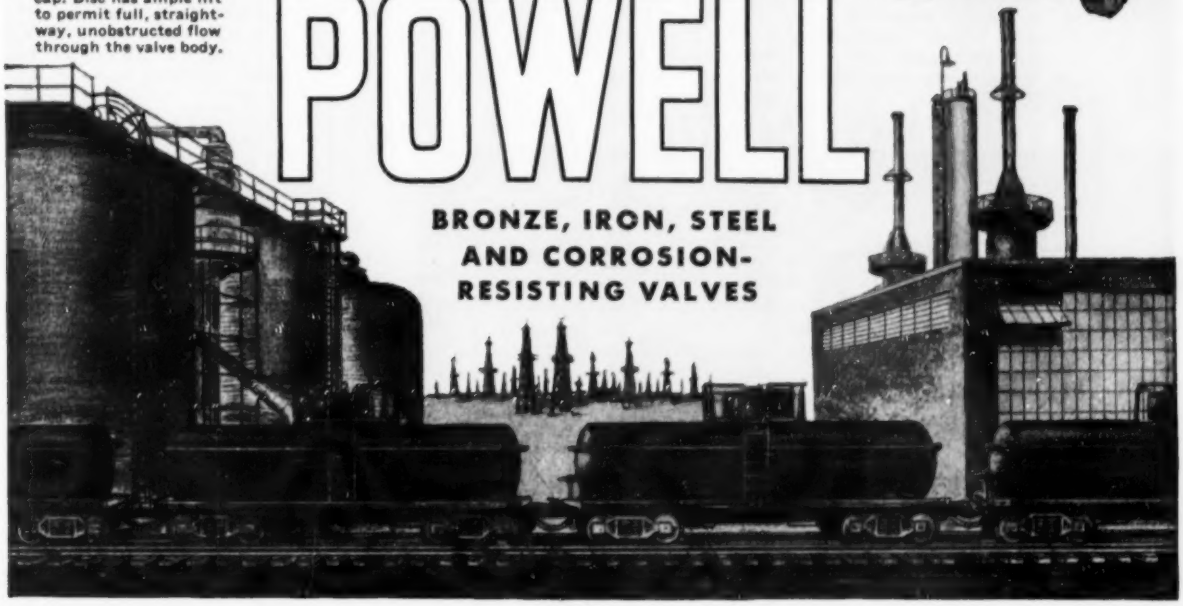


Fig. 1503—150-pound Cast Steel O. S. & Y. Gate Valve. Flanged ends and tapered solid wedge.

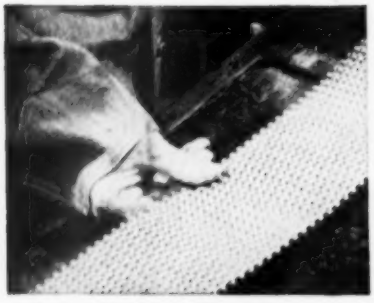
POWELL

BRONZE, IRON, STEEL AND CORROSION-RESISTING VALVES

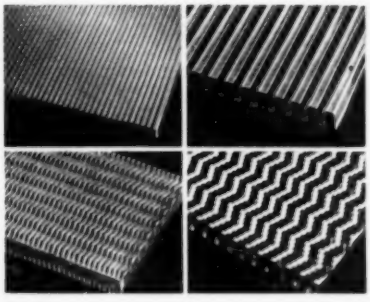


(To obtain more data on advertised products see page 1400)

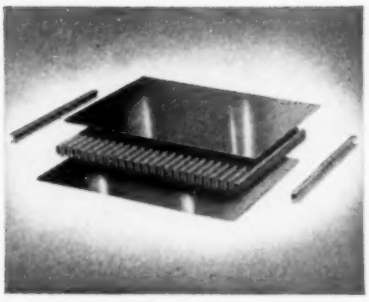
Here's how Trane brazes aluminum to solve tricky heat transfer problems...



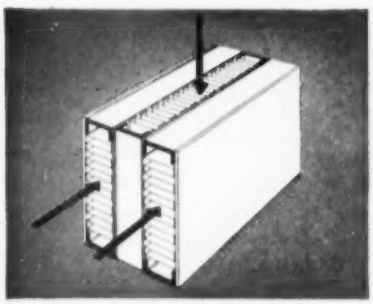
Corrugated fin surface for TRANE Brazed Aluminum Exchangers is formed in special presses from aluminum brazing sheet. Thickness can range from .005 to .032 inch; fin height to .50 inch; spacing 4 to 18 fins per inch.



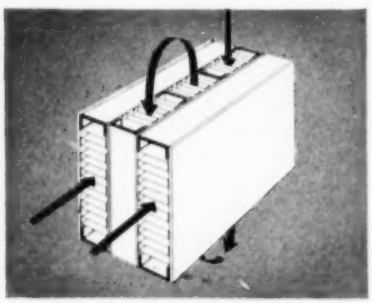
Many types of surface available. The brazed aluminum fins may be straight and continuous. Or they can be wavy, serrated or perforated to provide correct ratio of heat transfer to pressure drop.



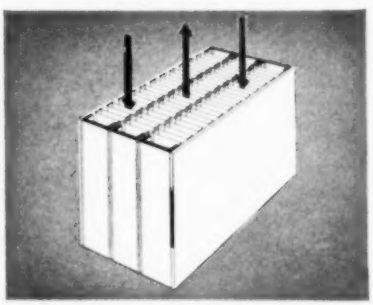
Exploded view shows component parts of a single passage. Fins, channels and parting sheets, all made from aluminum brazing sheet, become integrally bonded when assembled unit is submerged in a molten salt flux bath.



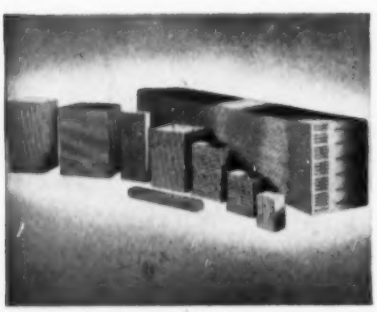
Cross-flow arrangement has fins in adjacent passages running crosswise to each other. TRANE Brazed Aluminum Surface can pack 450 square feet of heat transfer surface into one cubic foot of space.



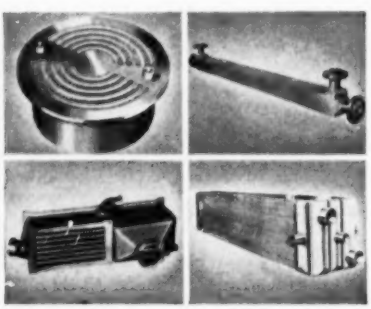
Multi-pass arrangement, like the cross-flow type, has fins in adjacent passages running crosswise to each other. With this arrangement, however, alternate passages are constructed to produce multiple passes.



Counter-flow arrangement has fins in adjacent passages running parallel to each other. A wide variety of different types of corrugated fin sheets can be used to handle different fluids in the same exchanger.



A wide range of core sizes is available up to 106 inches in length. Either bolt-on or integrally welded headers can be provided. Individual cores can be welded together to form larger multi-core units.



Design flexibility permits construction of units to handle practically any specification of heat transfer, pressure drop, volume, number and direction of passes. Some units handle as many as six different fluids simultaneously!

TRANE

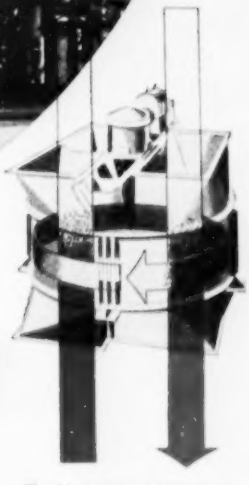
pioneers in the science of heat exchange

If you have a tricky problem in heat transfer . . . TRANE Brazed Aluminum Exchangers may be the answer. Contact your TRANE Sales Office or write direct.

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto. 80 U.S. and 14 Canadian Offices

with the

Ljungstrom Air Preheater



The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

In every processing vessel that burns fuel, air preheat shows the way to save as much as *one barrel out of every five*. When refineries alone burn over 200,000,000 barrels every year, this means the *Ljungstrom Air Preheater* can recover tens of millions of *production dollars* that are now going up the stack.

The Ljungstrom removes precious BTU's from exit gases and transfers them to combustion air. Its effectiveness can be gauged from the fact that every 35-40°F of preheat means roughly a 1% saving in fuel—and Ljungstroms now in use preheat air to over 600°F.

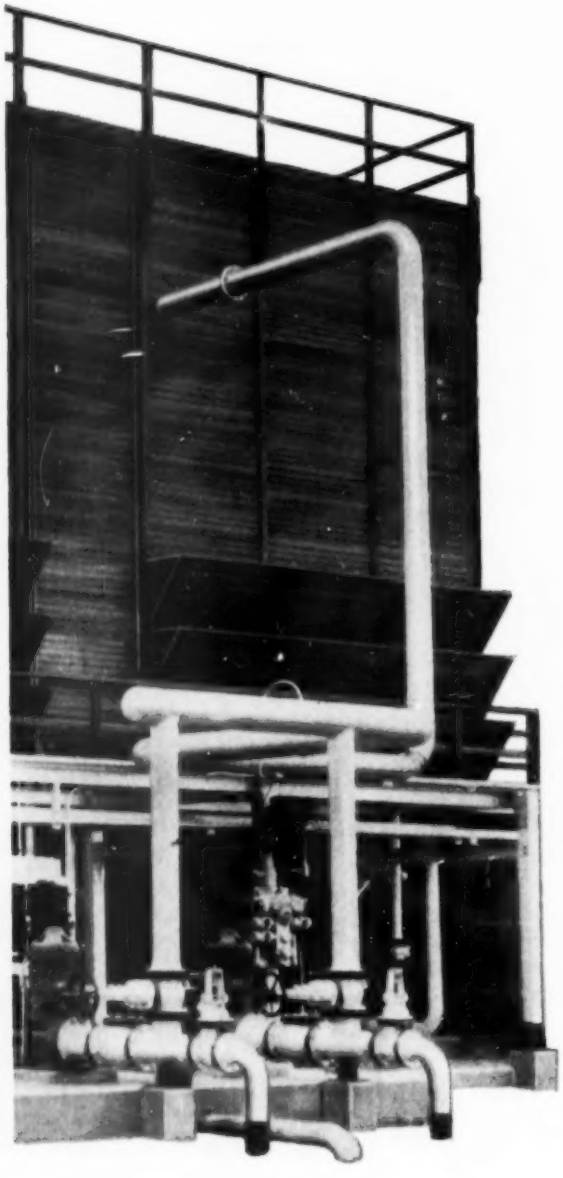
In addition to saving as much as 20% of your fuel, more effective fuel utilization means that your equipment can deliver greater throughput . . . can burn lower grade fuels with less slagging . . . lets you eliminate convection surfaces without reducing production.

In these days of high fuel costs, every process industry should consider the Ljungstrom for new installations or modernization of existing equipment. Call or write The Air Preheater Corporation for full details.

Wherever You Burn Fuel, You Need Ljungstrom

THE AIR PREHEATER CORPORATION 60 East 42nd Street, New York 17, N. Y.

YOU KNOW YOU'RE RIGHT!



Men in the petro-chemical industry who specify Pritchard cooling towers have the satisfaction of knowing they have made the right decision.

How do they know? First, Pritchard experts consult with them on exactly what is needed for the specific cooling job. Then, experienced Pritchard engineers help them select the right tower for that job . . . the unit with the proper capacity and design for efficient operation . . . maximum water-saving. Finally these men know they can depend on Pritchard to deliver such a tower because of Pritchard's acknowledged reputation for building reliable, rugged, quality units and the unconditional guarantee that Pritchard towers will perform as specified.

You'll know you're right, too, when you consult Pritchard—a founder member of the Cooling Tower Institute—about your cooling needs. Look in the classified section of your telephone directory for your nearest Pritchard representative or write direct to Pritchard's General Offices, Kansas City, Missouri.

You're right again when you specify a Pritchard QUINTAIR* *air-cooled heat exchanger for dependable, efficient cooling or condensing of liquids, gases or vapors. Quality construction assures long, trouble-free service . . . skillful design makes all parts that may require attention readily accessible for easy maintenance.*

**Registered Trade Name*

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Cooling Towers
Specialized Heat Exchangers
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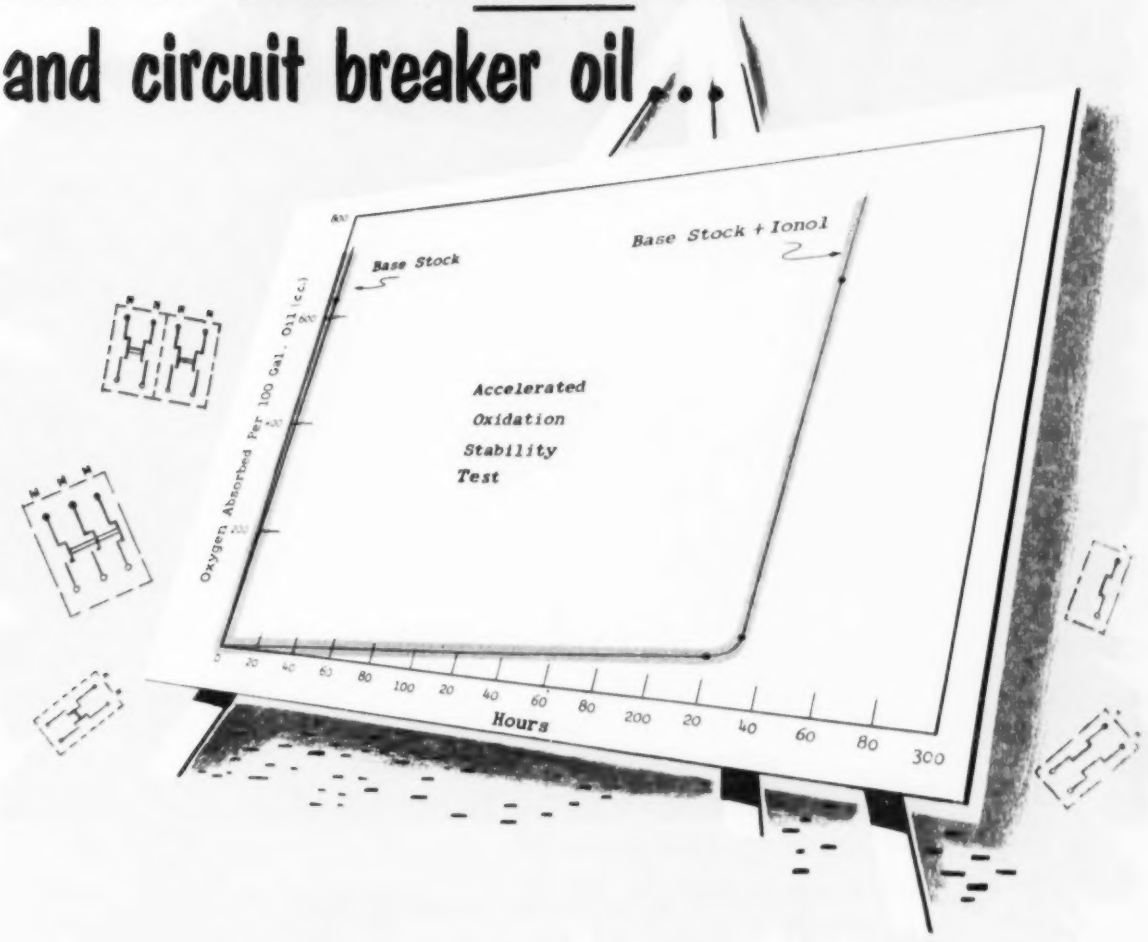
Representatives in Principal Cities from Coast to Coast

How to make a better transformer and circuit breaker oil...



In electrical insulating oils, as with most others, oxidation reduces efficiency and seriously shortens service life.

Peroxides attack cotton insulation on conductors. *Sludge* lowers cooling efficiency. *Acidity* encourages carbon-moisture suspensions which adversely affect dielectric properties. All of these undesirables are by-products of oxidation.

The inclusion of a single anti-oxidant additive—Ionol—in very small amounts, endows an insulating oil with a *three to five* times longer life of trouble-free operation than identical uninhibited oils. And Ionol is stable to color change in both use and storage.

Ionol has a long record of success as an anti-oxidant in gasolines and lubricating oils. A brief study will convince you that Ionol is the logical inhibitor for insulating oils . . . and that it is logical indeed to use an inhibitor when your goal is a better insulating oil!

IONOL®

the anti-oxidant additive

You are invited to write for the Shell Technical Bulletin, *Ionol as an Anti-oxidant in Insulating Oils.*

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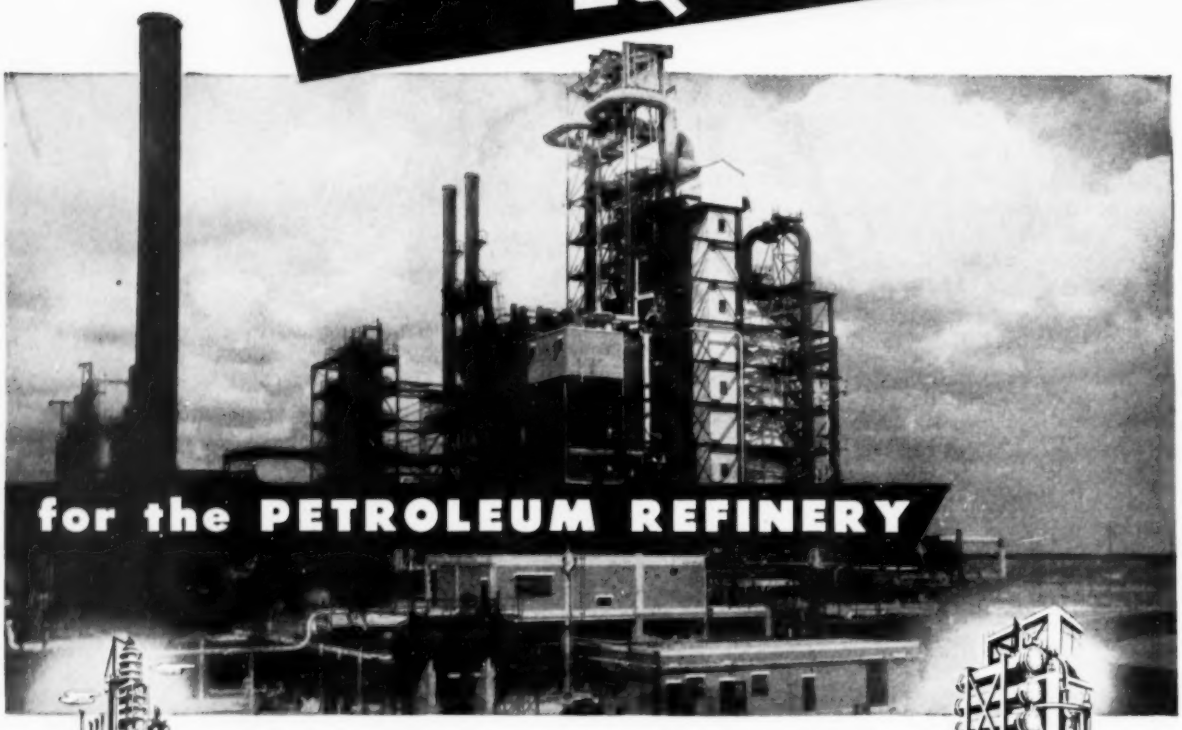
Essential EQUIPMENT



for the PETROLEUM REFINERY

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STEAM BOILERS

DROP FORGED STEEL VALVES AND FITTINGS

SELECT the process most suitable to your operating conditions and indicated future market requirements and then specify . . . Equipment by Vogt.

A wealth of research and engineering experience, combined with skilled operating personnel and exceptional manufacturing facilities, is incorporated in the wide variety of equipment we construct to all Codes.

Inquiries for detailed information on Vogt Products will receive prompt attention.

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REFRIGERATION MACHINERY

WAX PLANT EQUIPMENT

HENRY VOGT MACHINE CO., Inc.

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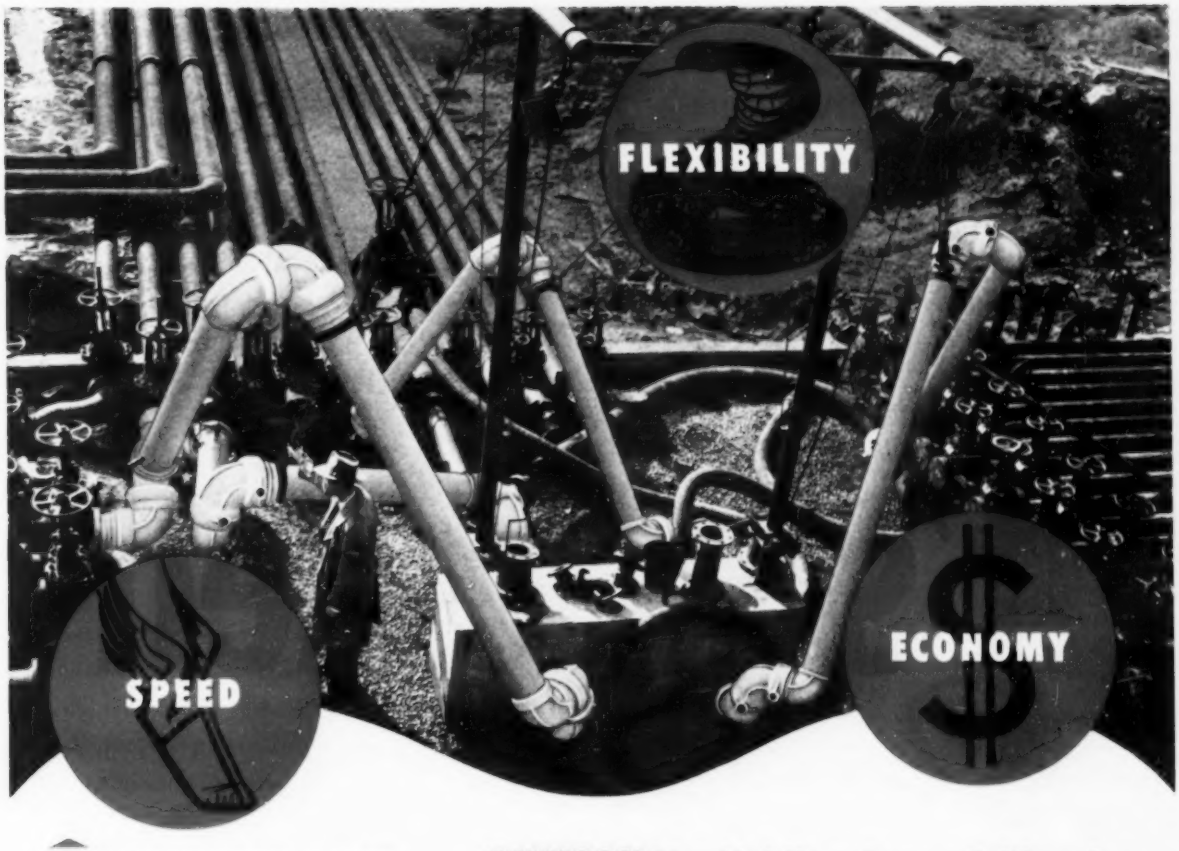
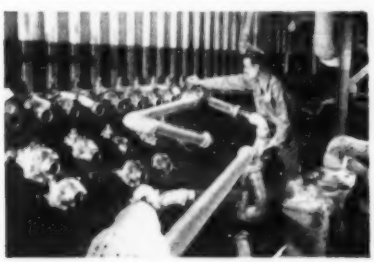


CHIKSAN Swivel Joints illustrated in this installation, facilitate the speedy, economical handling of various fluids through 16 lines from loading dock to manifolding pit — a distance of 800 feet. Since each line leads to a separate tank through the manifold, cross contamination is eliminated.



CHIKSAN Swivel Joints in the pump manifold above enable operator to pull base stock from outside storage into the plant and direct flow to proper vessel or proportioner.

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

CHIKSAN Manifolding Saves 3 Ways!

- √ ORIGINAL INSTALLATION
- √ NO CONTAMINATION LOSSES
- √ LOW COST OPERATION

Original cost of CHIKSAN flexible line manifolding installations often run as much as 50% less than fixed line manifolding operations which incorporate costly multiple valve and line systems.

A CHIKSAN manifolding operation is simplified in its entirety — providing complete flexibility, mobility and ease of operation in limited spaces.

CHIKSAN manifolding installations reduce line hook-up time — keep pit floor clear of lines thereby providing greater working areas.

CHIKSAN manifolding operations facilitate the transfer of all types of fluids safely and rapidly under extreme climatic conditions with no possibility of cross contamination.

CHIKSAN manifolding installations are specifically engineered for long life — easy and economical maintenance, and render years of trouble-free operation.

Our Engineering Research and Development Department will welcome inquiries on your manifolding problems.

Write for Catalog 53-C, Dept. PP-9

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it's oil

it's cracked

up to be

GENERAL REFRACTORIES

Wherever you see the towers and the framework of "cat crackers", you'll find refractory products doing the inside job. And Grefco is a major supplier of quality *refractories* to the entire petroleum industry.

Such products as HIGH STRENGTH BRIK-CAST and LITECAST-50 have become leading favorites among oil men for lining regenerator chambers and catalyst lines in fluid catalytic cracking units. Both materials are mixed at the plants and shipped to the job site ready for use.

HIGH STRENGTH BRIK-CAST is an abrasion resistant hydraulic setting refractory castable and LITECAST-50 is an insulating castable, also hydraulic setting and having an extremely low thermal conductivity (1.3 at 700°F mean temperature). Both materials have been developed particularly for cement gun application and the absolute minimum of rebound loss can be expected. In restricted areas where gun application is impossible, application by trowelling can be accomplished without changes in the mix.

For other equipment too—stack linings, heaters, stills, boilers—a Grefco product is available for every service condition. Throughout the process of petroleum refining, Grefco has the quality products to do the job well and the complete selection of products to do the complete job.

For the truly *complete refractories service*—call on Grefco!

GENERAL REFRACTORIES COMPANY

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Tag all the bases

IN THE PETROLEUM PROCESSING INDUSTRIES

Runners don't score unless they've touched first, second, third and home . . . nor will your sales campaign score in the petroleum processing industries unless it goes all the way to all four divisions!

No other magazine so effectively covers the interests of all four as ***Petroleum Processing,*** serving:

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Since 1945, refining capacity alone is up from 5 million to 8 million barrels a day; refining plant investments up from $565,000,000 last year to $750,000,000 this year. All four groups have expanded similarly, and ***Petroleum Processing*** right with them, as it serves ***all*** of these industries.

Tell your story to the ***entire*** petroleum processing industries groups. Tag ***all*** the bases by advertising in ***Petroleum Processing***. Ask for free copy of "What's Ahead for Petroleum" —a forecast to 1967.

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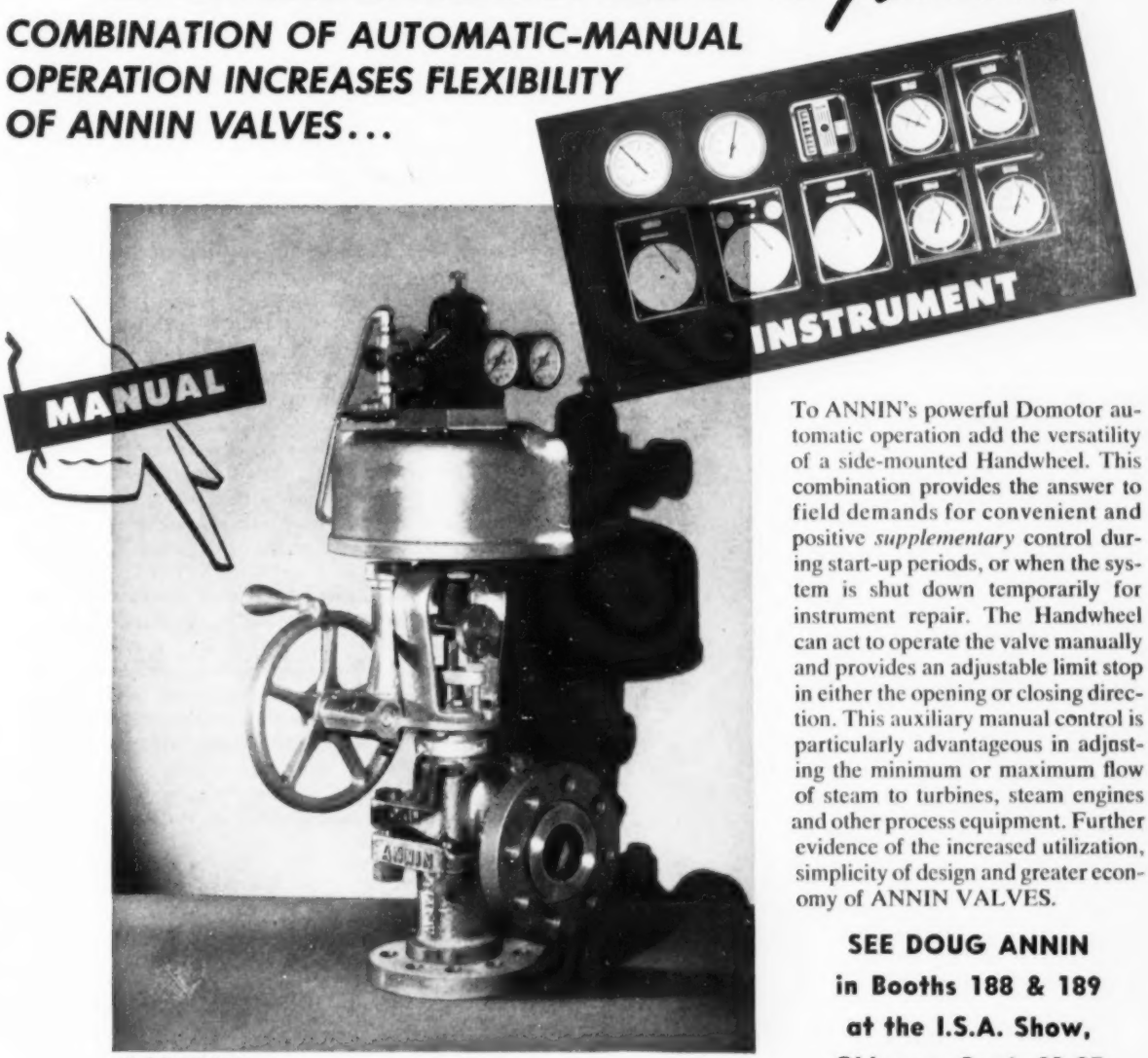
COMBINATION OF AUTOMATIC-MANUAL OPERATION INCREASES FLEXIBILITY OF ANNIN VALVES...



Model 1560 SMW

To ANNIN's powerful Domotor automatic operation add the versatility of a side-mounted Handwheel. This combination provides the answer to field demands for convenient and positive *supplementary* control during start-up periods, or when the system is shut down temporarily for instrument repair. The Handwheel can act to operate the valve manually and provides an adjustable limit stop in either the opening or closing direction. This auxiliary manual control is particularly advantageous in adjusting the minimum or maximum flow of steam to turbines, steam engines and other process equipment. Further evidence of the increased utilization, simplicity of design and greater economy of ANNIN VALVES.

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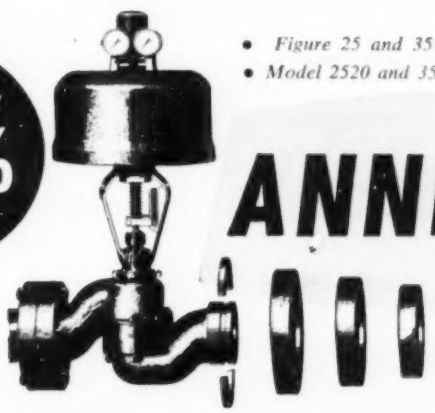
in Booths 188 & 189
at the I.S.A. Show,
Chicago, Sept. 21-25

Featuring these NEW Annin products:

- *Figure 25 and 35 Manual Valves*
- *Model 2560 and 3560 Domotor Valves*
- *Model 2520 and 3520 Cylinder Valves*
- *Model 5060 Wee Willie Control Valves*

CUT INVENTORY 50% WITH



ANNIN *Control* **VALVES**

THE ANNIN COMPANY 3500 Union Pacific Avenue
Los Angeles 23, California

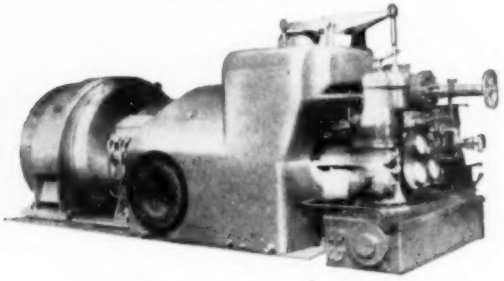
 (To obtain more data on advertised products see page 1400)

"These unique steam seals control turbine shaft leakage, lengthen seal life"

Westinghouse has perfected carbon ring glands by this ingenious two-way application of spring pressures. Two "garter" springs accurately align and support each gland around the shaft. Precisely determined tensions, compensating for the weight of the ring itself, effect a close seal *all around* the shaft without abrasion or binding. Leakage around the rings is prevented by six spring-loaded, stainless steel buttons which seal the gland face against its housing. Based upon precision mating surfaces instead of heavy spring pressure, gland rings "float" freely with natural shaft movement. For many years, this perfectly balanced spring and gland combination has proved its ability to control steam leakage along the shaft with minimum maintenance.

The greater simplicity and reliability of this gland design indicates the value of Westinghouse Engineering in steam turbine operation. Based on over 50 years' experience, this engineering contributes the many bonus features found only in Westinghouse General-Purpose Turbines. It is a basic reason why more and more power engineers are relying on "Westinghouse" when needing steam drives. Put this unequaled background to work for you by calling your local Westinghouse Office or writing Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh, Pennsylvania.

Turbines for every industrial use



Type M General-Purpose Turbine

A single basic design with modifications for every type of service is shown here as a turbine-generator set. One of its many applications would be operation as a noncondensing unit with exhaust steam used for heating or processing. Available in ratings 1000 to 10,000 hp and 1000 to 7500 rpm, it utilizes every Westinghouse design advantage to attain exceptionally high efficiency. J-50560

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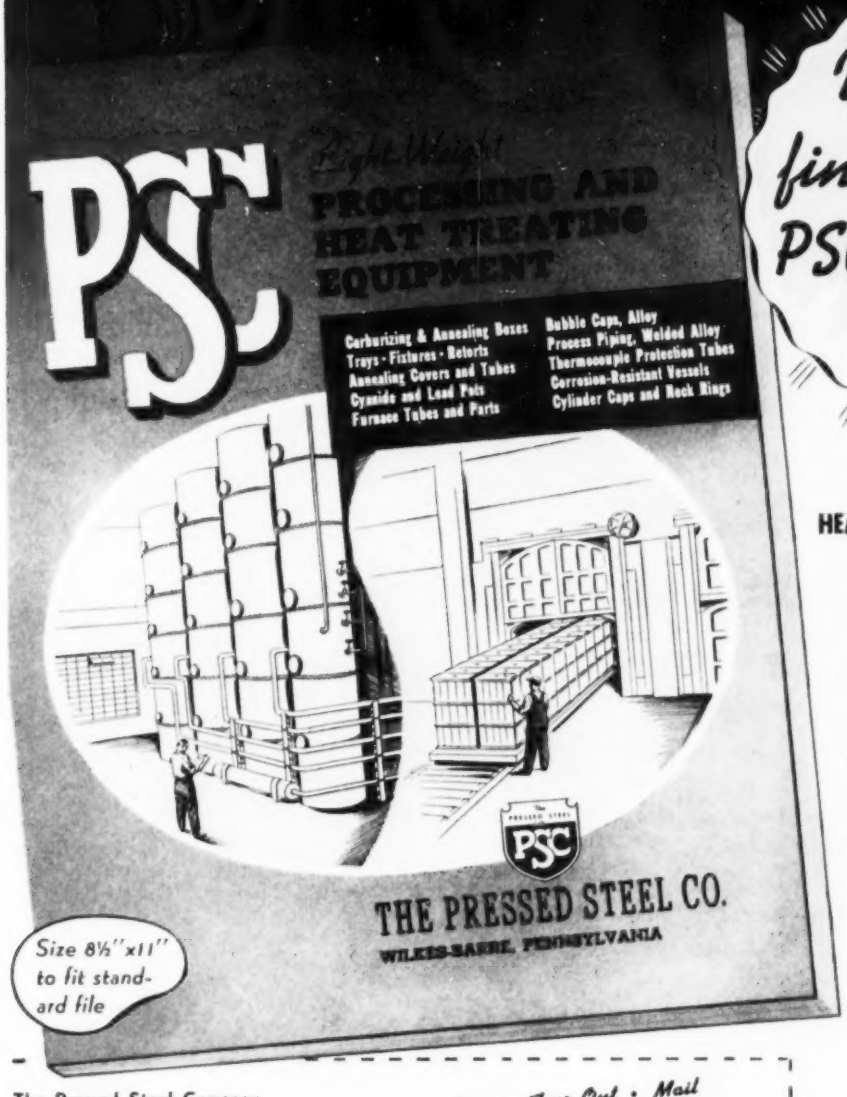

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Covers, annealing (elevator furnace)
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Muffles, carburizing
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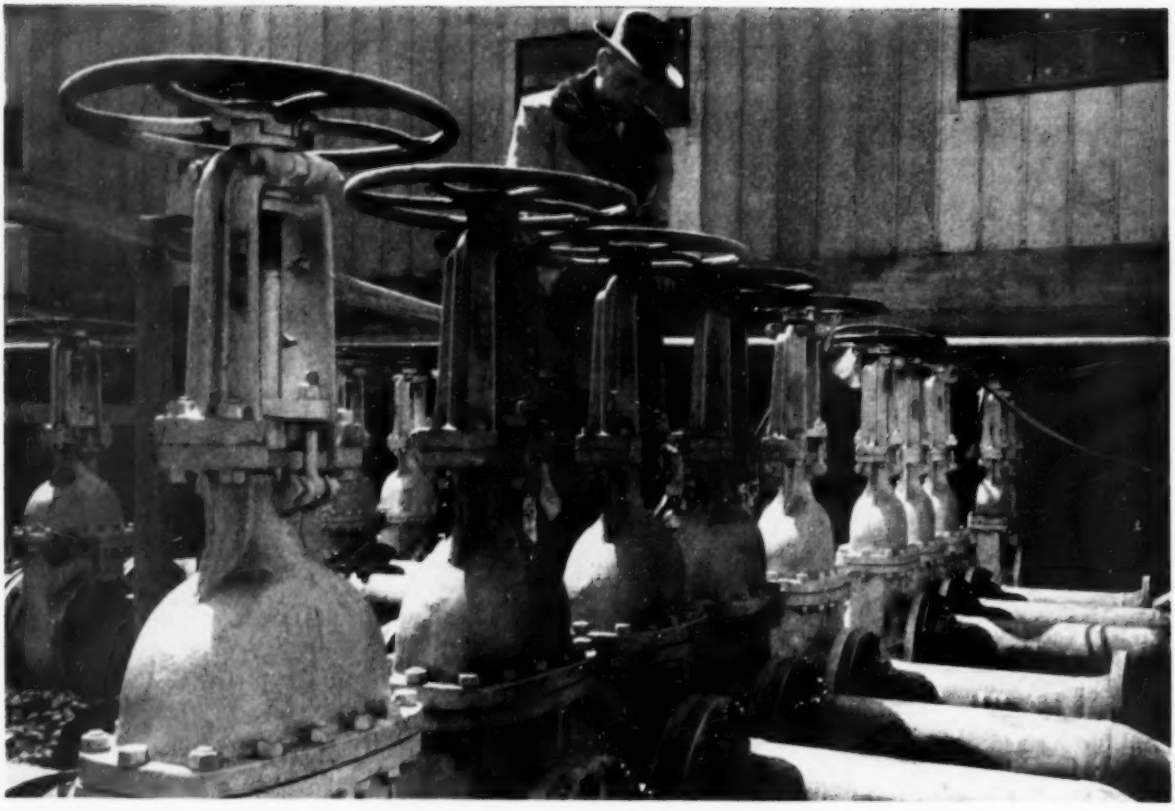

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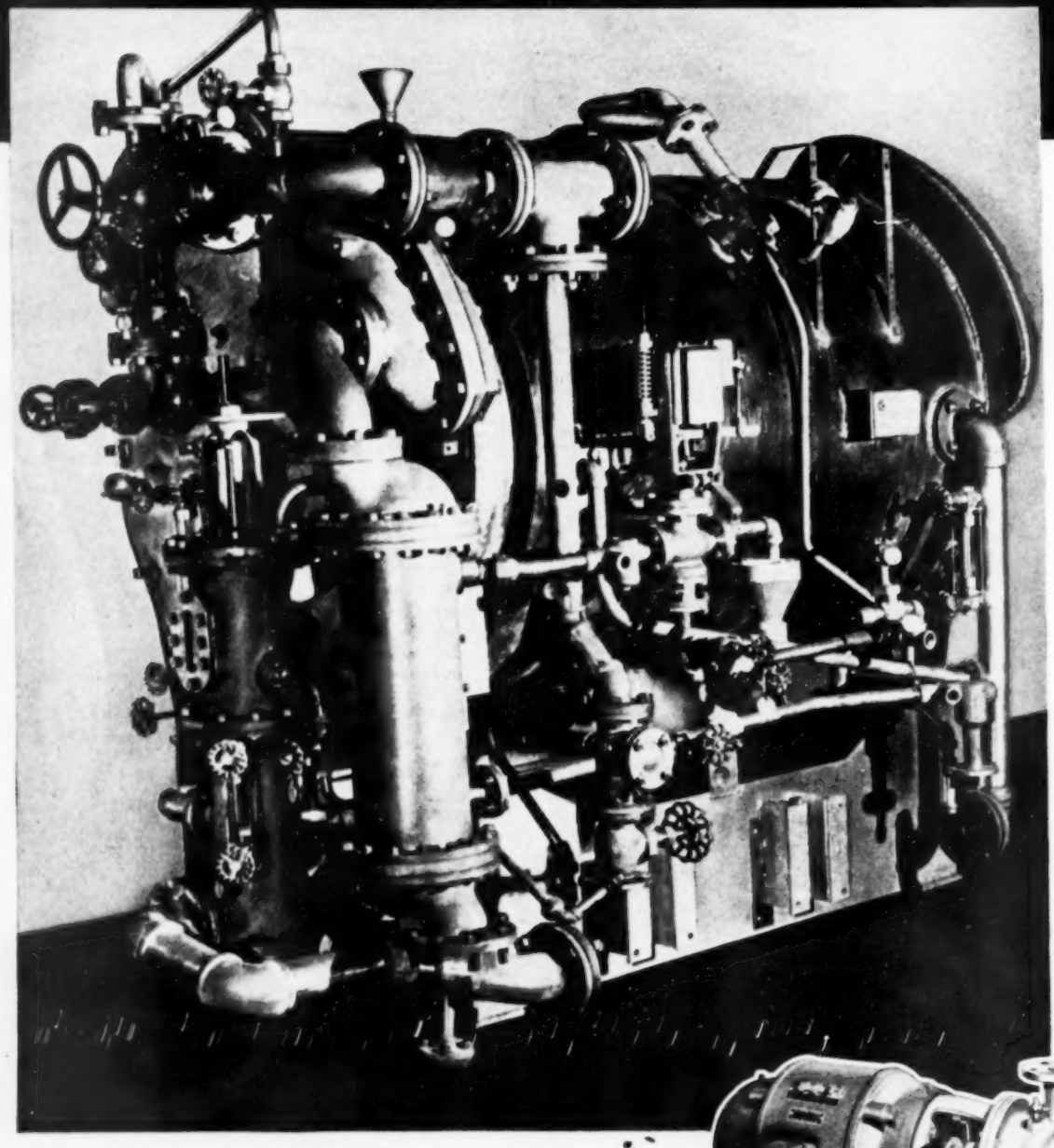
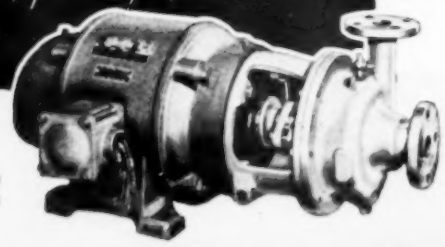


Salt water evaporator manufactured by Griscom-Russell Co., Massillon, Ohio. Ampco Metal is the principal component of construction.



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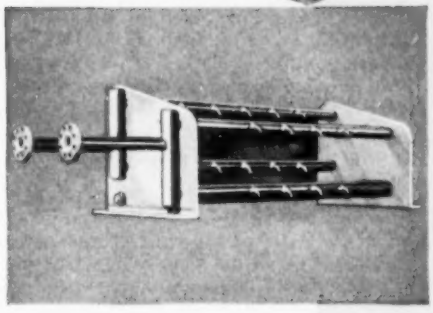
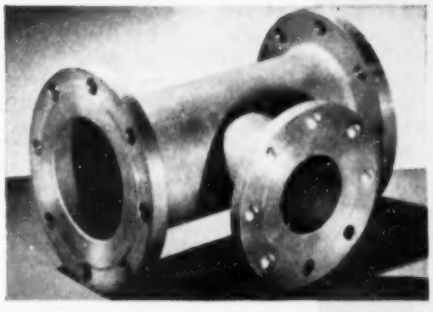


Sulfuric acid spray unit.



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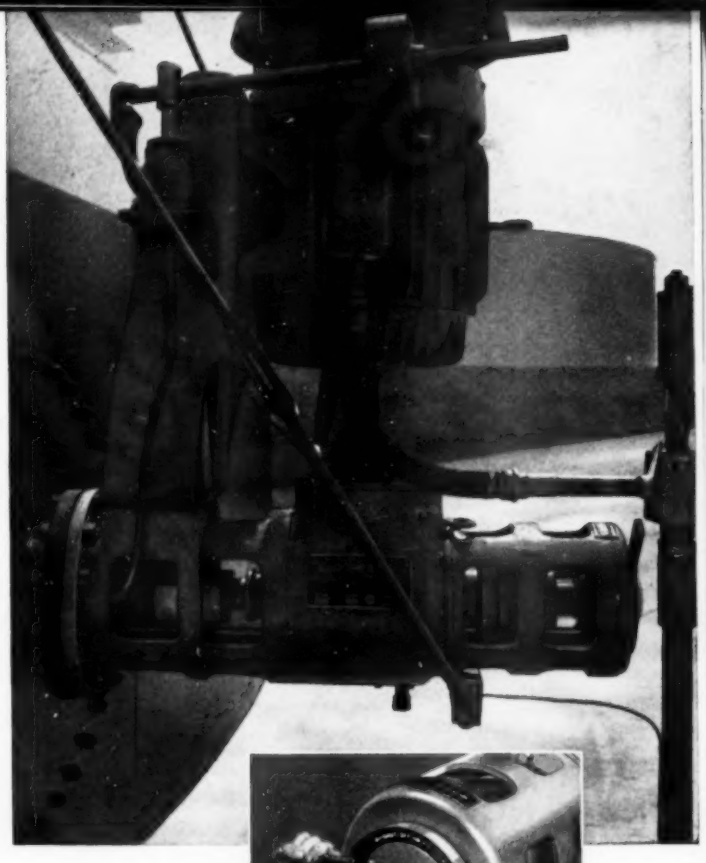

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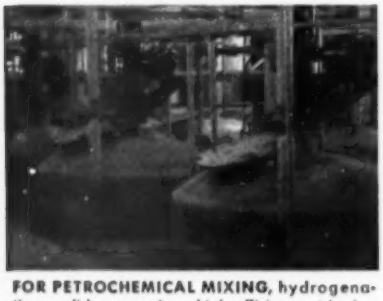

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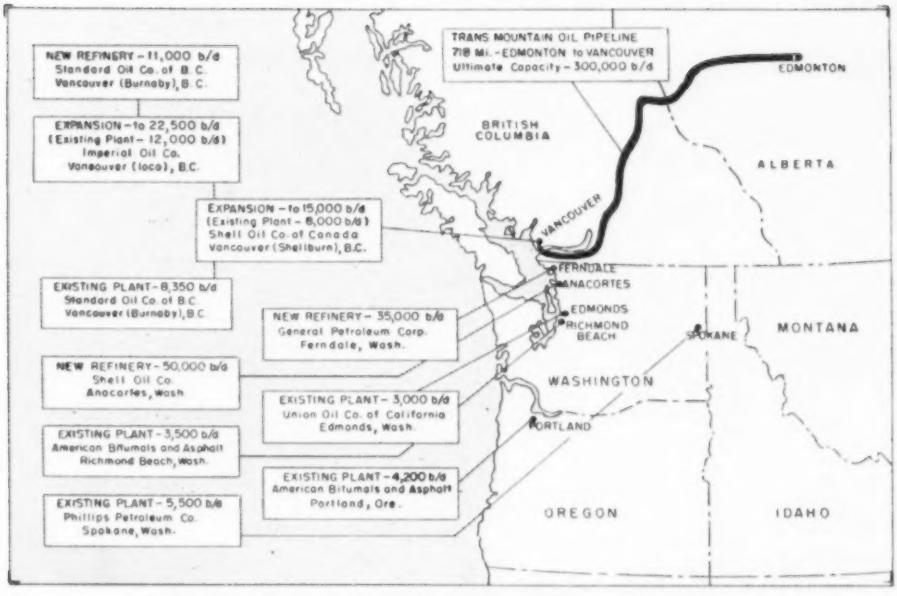


SCORE TO DATE in the Pacific Northwest: three new refineries and two expansion projects, for 113,500 b/d of new capacity

Major Refining Area Takes Shape

Pacific Northwest boosting capacity by 250%; will be 158,050 b/d by 1955

By FRANK BREESE

Pacific Coast Editor

A NEW refining center of major proportions is rapidly shaping up in the Pacific Northwest. Big decisions have been made concerning that area in the past year—and still more are in the making.

Here are the highlights of what's happening there in the way of refineries:

Three new refineries are either under construction or in the planning stage—with a total charge capacity of 96,000 b/d—General Petroleum at Ferndale, Wash. (35,000 b/d); Shell Oil at Anacortes, Wash. (50,000 b/d), and Standard of California at Vancouver, B.C. (11,000 b/d).

Two expansion projects for existing plants will boost their capacity by 17,500 b/d—Imperial Oil (going from 12,000 to 22,500 b/d) and Shell Oil of Canada (from 8,000 to 15,000 b/d), both at Vancouver.

Additional new plants are still on the horizon. Standard of California bought 2,000 acres just north of Seattle last year as a possible refinery site—and still has it. Pacific Oil & Gas, a new independent, may yet go through with plans for a 10,000 b/d refinery at Tacoma, Wash.

Summing up: The three new refineries and two expansion projects represent 113,500 b/d of new capacity. Existing capacity totals 44,550 b/d. That makes a total of 158,050 b/d crude charging capacity which should be operating by 1955.

Keystone of all this activity is the new 24-in. crude oil pipeline which late this month will start bringing Canadian crude from Edmonton, Alberta, to Vancouver, B.C. The Pacific Northwest, long dependent on a tenuous tanker run for both crude and product, will then begin to see petroleum self-sufficiency ahead.

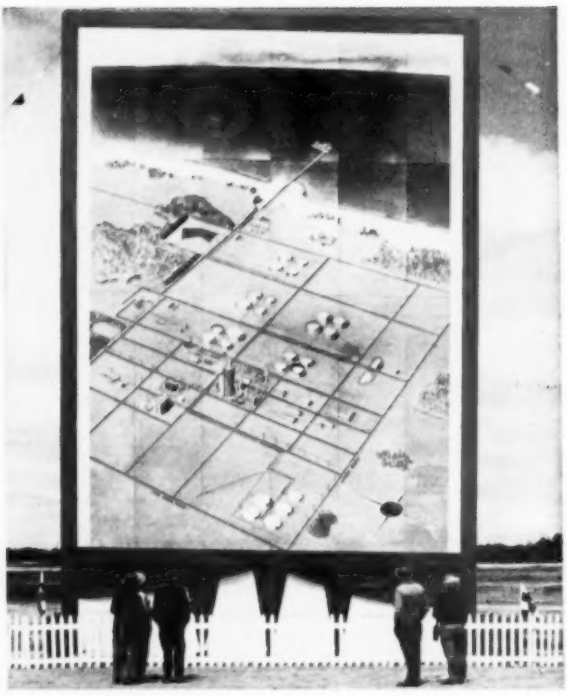
The 718-mile line is being built for Trans Mountain Oil Pipe Line Co. at a cost of $92 million. Initial rate of flow through it will be 75,000 b/d; rate will be increased to 120,000 b/d in October and to 150,000 b/d next year. Ultimate capacity can be 300,000 b/d by adding additional pumping stations.

The line itself was expected to be completed the last week of August or the first week of September, according to Trans Mountain. Crews of pump men, mechanics and inspectors have been testing the last 27 miles of the west end of the line. The line originates at a tank farm in Edmonton adjacent to Interprovincial Pipeline's terminal. Western terminus is a marine terminal at Westridge, Vancouver harbor.

Unusually heavy rains in the mountains have washed down several slides during the season, handicapping construction. But the engineers have clung to their schedule.

The big inch line, dubbed "inch by inch" because of the tortuous terrain it has crawled over, crosses some of the most rugged topography in North America. As a mountain project, it has

LIFELINE OF EXPANSION in the Pacific Northwest is the 24-in. crude oil pipeline from Edmonton to Vancouver. The line traverses some of the ruggedest terrain in N. America, of which the above (Coquihalla Canyon, 100 mi. from Vancouver) is typical



FIRST NEW REFINERY resulting from influx of Canadian crude will be General Petroleum's 35,000 b/d plant at Ferndale, Wash. Residents of area are given an idea of what plant will look like from this 40-ft. blow-up of a sketch of its plot plan

been one of the most difficult pipe laying undertakings, with problems differing from the task of laying pipe across the Middle Eastern deserts, say engineers.

New Refinery Projects

General Petroleum's 35,000 b/d refinery at Ferndale is most advanced of the three new projects.

Target date for completion of the $35 million plant is Nov. 1, 1954, and it is expected to go on stream by the end of 1954 or early 1955. It will be the first large, modern refinery in the territory.

Located 12 miles below the Canadian border on an 850-acre site facing Puget Sound in Whatcom County, the plant will receive crude oil from a spur-line of the Edmonton-Vancouver trunkline.

Processing facilities will include a crude distillation unit, gasoline reformer, Thermofor catalytic cracking unit, thermal cracking unit with vacuum distillation tower, and a catalytic polymerization unit. About 350 persons will be employed.

GP expects the plant to produce around 16,300 b/d of gasoline, 10,000 b/d of Diesel and stove oils, and 6,200 b/d of fuel oil.

This project has been termed "probably the most important expansion in General Petroleum's history" by Robert L. Minckler, president. President B. Brewster Jennings and a group of top brass of Socony-Vacuum, of which GP is an affiliate, flew out for a dedication ceremony July 18, showing the importance attached to this venture.

Preliminary engineering, completed in May, yielded 1,900 drawings, charts and schedules forming the preliminary plans.

Shell Oil has selected Anacortes, Wash. as the site for its 50,000 b/d refinery.

Shell is now picking up options on land to consolidate its holdings at March's Point on Anacortes outskirts, overlooking Puget Sound. It hopes to have the ground cleared and the engineering completed by the end of this year.

No completion date has been announced; it is expected, however, that the first unit will be in operation sometime during 1955. Shell said it has earmarked $75 million for the project.

Details of the plans are sparse. R. W. McOmie, West Coast refining coordinator, said the refinery will be "one of the most modern plants of its kind in the nation with catalytic and reformer units." Docks, storage tanks and other facilities will be built. The initial Shell announcement said 1,500 persons will be employed.

Standard of California is about to start construction on its 11,000 b/d refinery at Vancouver, B.C.

Standard said the plant will be finished by the end of 1954 at a cost of $10 million. It will be built next to the company's present 8,350 b/d refinery in a section called Burnaby, near the western terminal of the Edmonton-Vancouver crude line.

The refinery will include catalytic cracking and polymerization facilities and a two-stage distillation unit. Improvements are planned for storage tanks, wharfs, warehouses and other facilities at the other refinery.

Construction and operation are under Standard Oil of British Columbia, a subsidiary.

Possible Projects

Apart from the concrete events, there have been other developments and ruraors which make the situation fluid and keep regional chambers of commerce breathless with expectation.

Standard of California still has 2,000 acres of land 20 miles north of Seattle, acquired last year for $900,000 as a

possible refinery site. It is suitable for tankage and distribution as well as for a refinery; Standard has said nothing since buying it.

Union Oil scrapped its plans for putting up a refinery after optioning some land. It dropped the options and sold its 100,000 shares in the Edmonton-Vancouver pipe line (for a neat profit of $3,200,000: purchase price—$1,000,000; sale price—$4,200,000).

Subsequently Union bought 10% interest in a Billings-Spokane product pipe line.

An independent firm identifying itself as Pacific Oil and Refining Co., formed by a Midwest group, reported in January that it was planning to build a 10,000 b/d refinery at Tacoma, Wash. Since then, however, the project appears to have cooled off. Idea was to establish a source for Independent marketers, relieving them of their dependence on major company suppliers.

Though still regarded a possible project, differences over arrangements reportedly have stalled definite action.

The other three West Coast majors —Richfield, Texaco and Tide Water Associated—have said nothing about plans for building refineries in the Northwest.

Richfield does have 50,000 shares in the Edmonton-Vancouver crude line. Texaco and Tide Water have no visible interests in current pipe line and refining projects in that territory.

Petrochemicals also are in the wind for the Pacific Northwest—although nothing definite has yet come out along this line.

The Seattle Chamber of Commerce reports that four chemical firms are interested in locating in the vicinity of the GP and Shell plants. A spokesman said, however, the chamber was not at liberty to disclose their identity.

A petrochemical plant has been read into the figures for Shells 50,000 b/d refinery—the estimates of $75 million cost and 1,500 employes. Shell, however, disclaims any present plans for a petrochemical plant. But both figures which give rise to the conjecture appear to be maximum estimates which may not necessarily be reached in a strictly refinery operation.

Another factor in the petrochemical situation is natural gas, frequently an important raw material in petrochemical processes. Three groups are jockeying to serve the market, but hearings have delayed positive action toward constructing a pipe line.

Westcoast Transmission Co., with its source at Peace River in northern British Columbia, has been granted permission by the Canadian board of transport commissioners to pipe natural gas to southern British Columbia and the Pacific Northwest states, as far as Portland, Ore. Westcoast has been waiting for the U.S. Federal Power Commission to take action on its application. Without the U.S. market, the project would be uneconomical.

The Pacific Northwest Pipe Line Co. has lined up a source in the San Juan Basin in New Mexico. Distance had been deemed a handicap because of the cost, but the Colorado Interstate Gas Co. has agreed to buy 110,000 mcf/d, leaving 200,000-250,000 mcf/d for the Puget Sound area, according to the Seattle Chamber of Commerce. A Colorado outlet would make the line more feasible financially. A chamber representative said Seattle, Tacoma and Portland favor this project.

The Alberta Natural Gas Co., which proposes to pipe gas from the Pincher Creek field of Alberta, seems to be running third.

The chamber is still hopeful that the Northwest will have natural gas by 1956.

Supply and Demand

Two more factors still have to be taken into account in evaluating the Pacific Northwest as a refining center: (1) the availability of product in the area via product pipe lines, and (2) the general supply-demand situation in the area.

Two major product pipe line projects are in the works.

A 30,000 b/d products pipe line will be built between Billings, Mont. and Spokane, Wash., by the Yellowstone Pipe Line Co., jointly owned by four groups (Continental Oil Co., 40%; Interstate Oil Pipe Line Co., a Jersey Standard affiliate, 40%; Union Oil of California, 10%, and the H. Earl Clack interests, 10%. Mr. Clack is a leading independent jobber in the eastern Washington-Idaho area).

The 8-in. line is scheduled for completion during the summer of 1954 at a cost of $20 million. Ultimate capacity will be 50,000 b/d, said Yellowstone. Conoco and Carter terminals to be built at Bozeman, Helena, and Missoula, Mont. are slated to be in operation by the end of this year.

Output at Spokane will run between 10,000 b/d and 15,000 b/d at the beginning and will be scaled higher as demand requires.

A 15,000 b/d pipe line is being built between Pasco, Wash. and Spokane by Salt Lake Pipe Line Co., a subsidiary of Standard of California.

The 135-mile 8-in. line is scheduled to be finished Oct. 1 at a cost of $4 million. It will carry two grades of gasoline and several grades of heating oil. The products will be brought to Pasco through the company's pipe line from Salt Lake City and by barge up the Columbia River.

At the same time, Salt Lake Pipe Line Co. is boosting the capacity of its Salt Lake City-Pasco line to 42,500 b/d. Output at Pasco will be 22,500 b/d.

Recapitulation: Roughly 15,500 b/d of additional products will be pumped into the Pacific Northwest from the Rocky Mountains next year.

The lines from Billings and Salt Lake will have a combined capacity of 72,500 b/d next year. About 32,500 of it will go to the Pacific Northwest, the rest being drawn off for intermediate markets.

Significant aspect is that Spokane, capital of the "Inland Empire," will be served by two pipe lines. It has been supplied by truck and trailer transports.

Here's the way the supply-demand situation will be affected: This year the Pacific Northwest has been consuming approximately 285,000 b/d of oil—all shipped in except some 30,000 b/d piped and trucked in from the Rockies.

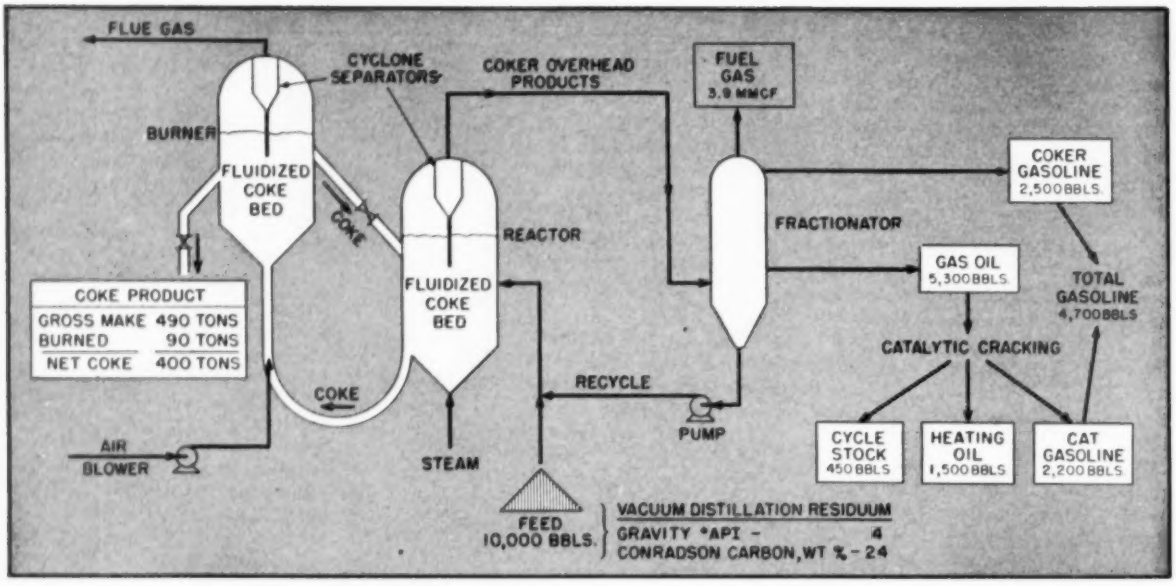
Existing refineries have been processing 44,500 b/d. Subtracting that amount plus the 30,000 b/d from the Rockies leaves 211,500 b/d of finished products that must be shipped in.

By 1955, there will be 198,000 b/d of crude available for the Edmonton-Vancouver pipe line, according to a Canadian Bechtel estimate. Pipe line capacity is to be stepped up to 150,000 b/d, later 200,000 b/d and ultimately, 300,000 b/d.

By 1955, refining capacity will be 158,050 b/d; pipe line output, at least 32,500 b/d—a total of 190,550 b/d. Demand will be 313,296, according to a study made by Stanford Research Institute.

This is what's significant: Almost totally dependent today on California, the Pacific Northwest by 1955 will rely on California for only a third of its petroleum needs.

The big question today is: How soon will even that third be supplied by additional new plants? It may well be that the Pacific Northwest may soon be a net exporter of refined petroleum products.



YIELDS AND FLOW for a typical installation of the new Fluid Coking process. Data are for the particular feed shown

New Fluid Coking Process

Gives high yields of liquid products, utilizes fluidized solids technique

FLUID Coking is the newest process available to refiners to help them reduce their yields of residual products. Developed by Standard Oil Development Co., the process is said to give over 60% yield of light products in typical operation on low value feed stock. The coke produced is in the form of grains the size of beach sand.

The Fluid Coking process applies the principle of the "fluidized" movement of solids by means of compressed air, which is the essence of the Fluid catalytic cracking process introduced 10 years ago by S.O.D. The chief difference between the new process and Fluid catalytic cracking is that coke particles replace the catalyst in the reactor and, in place of the regenerator, a coke burner burns enough of the particles to provide heat for the process, coke is withdrawn continuously to maintain the proper inventory in the system and the remaining hot coke carries heat back to the reactor. The process is not catalytic.

Advantages of Fluid Coking are said to be lower investment and operating costs and the ability to process a wide range of low grade stocks not suitable for present processing methods. Operating advantages are in the process being continuous and in its not normally requiring an external furnace.

Affiliates of Standard Oil Co. (N.J.) have already shown their faith in the process by announcing plans to install three commercial units.

Engineering contractors are preparing bids for a 3,000-b/d unit at the Billings, Mont., refinery of Carter Oil Co. Esso Standard Oil Co. plans a 10,000-b/d plant at Baltimore, Md., and a 20,000-b/d unit at its Baton Rouge, La., refinery. The process is available to all refiners on license, at reasonable royalty rates.

Equipment requirements for Fluid Coking and consequently plant investment, are said to be far more independent of the type of feed than with some of the older coking processes. Residual oils with initial boiling points as low as 600-700° F. can be handled, as well as vacuum residua with 1100° F. i.b.p. or higher. Feed stocks with gravities as low as 1.8° API or heavier, or with Conradson Carbons as high as 35%, have been processed. With this flexibility, periodic changes in feed stock can be handled without difficulty.

An example of the adaptation of Fluid Coking to a typical refinery is shown in the accompanying flow chart. The crude oil residuum to be coked is injected into a fluilized bed of coke particles in the reaction vessel. The temperature of the bed is 950°-1050° F.

In the reactor the feed stock is substantially completely converted into overhead vapor and coke; the latter deposits on the coke particles already in the fluidized bed. The vapor products are taken overhead through a cyclone separator which removes most of the entrained coke and returns it to the reaction zone. The overhead product passes to conventional separation equipment. A small amount of recycle bottoms is returned to the reactor.

A stream of coke is transferred like a fluid through a standpipe-riser system to the burner vessel. Air is supplied to burn enough of the coke (perhaps 1/5 of the coke produced) to provide heat for the process. The hot coke carries heat back to the reactor, completing the continuous circuit.

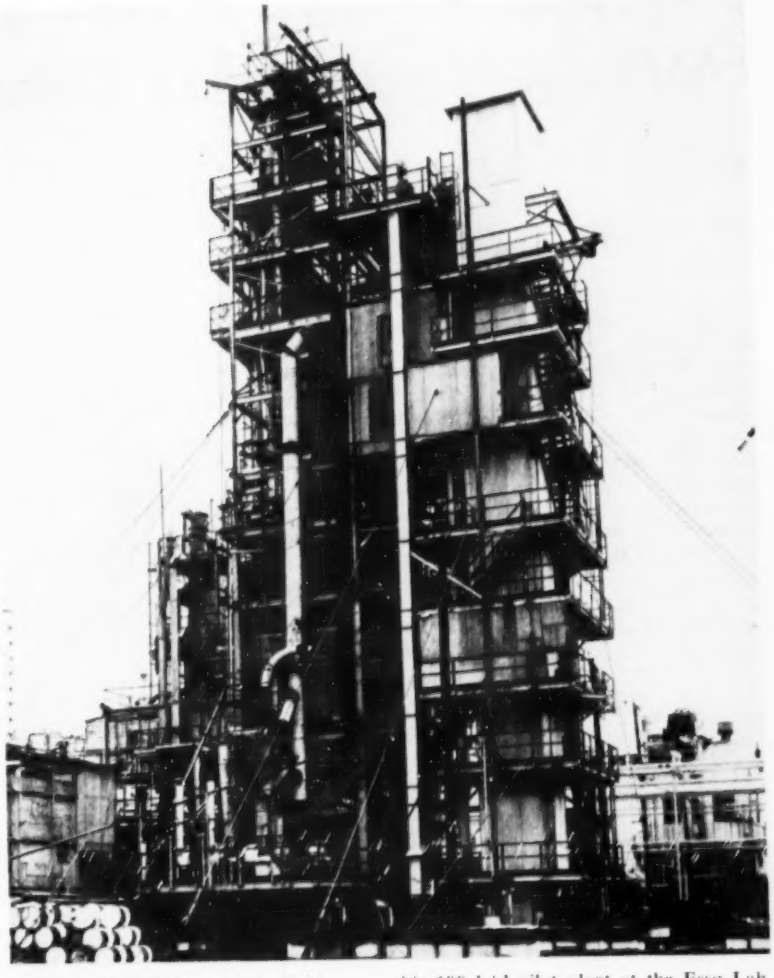
In the typical example given in the

COKE PRODUCED in the new process looks like coarse beach sand

flow chart, 10,000 bbls. of 4° API gravity vacuum distillation residuum would be converted to 2,500 bbls. of coker gasoline and 5,300 bbls. of gas oil, which in turn could be cracked to give some 2,200 bbls. of gasoline and 1,500 bbls. of heating oils. Thus a total of 6,200 bbls. of valuable light products would be recovered from 10,000 bbls. of low value feed stocks. An additional inducement to the refiner, in this example, would be the fact that he would not be required to blend some 4,000-6,000 bbls. of distillate oils with the residuum, as would be the case were it to be sold for fuel oil.

In this example, 490 tons of coke would be produced from the 10,000 bbls. of feed stock, but 90 tons of this would be consumed to provide heat for the process. The coke produced in particle form is of a grade suitable for either refinery fuel or for burning in power plant boilers and other industrial applications. However, with some feed stocks the coke would have greater value, as for the production of carbon electrodes for aluminum manufacture.

Intensive work on the development of Fluid Coking was begun by Standard Oil Development Co. four years ago. Experience in the "fluidized solids" technique with Fluid catalytic cracking made progress rapid to the pilot plant scale. A 100-bbl. pilot plant at the Esso Laboratories in Baton Rouge, previously used to develop Fluid cracking, was modified and has been operating successfully as a Fluid Coker for the past year.



PROVING GROUND for Fluid Coking was this 100 b/d pilot plant at the Esso Laboratories in Baton Rouge, La.—originally used to develop Fluid catalytic cracking

No. 8 in a series on How to Order Equipment

How to Get What You Need When You Order Electric Motors

By D. P. THORNTON, JR., Southwestern Editor

ELECTRIC motors are the heart-muscles of the modern refinery and petrochemical plant, as the trend in pump drivers long has been towards motors. They also run most cooling tower fans and a host of other applications.

Depending on the geographic area, probably 50% or more of motor manufacturers' sales to the oil industry in the past few years have been for new applications. Motor suppliers generally appear to have less trouble securing needed information on orders or bid invitations from their customers than have been noted with other equipment items discussed in this series. Nevertheless, they report that there is room for improvement.

Because the electrical industry has so highly standardized its products, extremely detailed purchasing information ordinarily is not needed even though an electric motor is more complicated than it may appear. Thus it is seldom that a refinery or petrochemical plant problem is encountered which requires a custom-built motor. So, the big question is: "*which* standard design?"

To help answer this question does not mean the customer can call a hypothetical "Lightning Electric Co." and order "a five-horse 220 volt A.C. motor for a pump."

What kind of pump? Does it start under load? Continuous or intermittent duty? What kind of hazards are present? Can the pump be overloaded? What is the speed and will it be varied? What is the location of the motor—indoors, outdoors, and where geographically? These are just a few of the questions the supplier needs answered unless he is uncommonly expert with a crystal ball.

There are a number of things the buyer should do, in addition to supplying vital information, to assure that he gets a motor suited to his application. The vital information includes power supply characteristics, desired speed and horsepower requirement.

Even then his supplier might be able to suggest more economical power arrangements, resulting in long-term savings, were all the details given. Thus he might avoid the expense of certain types of controls or secure a more favorable power rate and the like. There also are certain things the buyer can do to expedite filling his order and perhaps prevent misunderstandings and trouble later.

For instance, it may make considerable difference in the type of motor which his supplier would recommend if advised of the geographic location of the plant, what kind of environment the motor will have and what kind of maintenance the plant staff is prepared to give. The immediate reaction is "why?" when considering that the motor might be used for identical outdoor service on a pump in refinery or chemical plant in Chicago or Texas City, Texas. It will be supplied with identical power, controlled similarly and do the same job, either place.

In this case it is the radical difference in environment which may make a standard explosion-proof (Class 1 Group D) design quite satisfactory in Illinois but have a reduced service life in Texas. In Illinois, ordinarily, there will not be the long periods of high humidity encountered on the Gulf Coast; thus less chance for moisture condensation in the motor case and windings during shutdowns which usually paves the way for an early failure. Even "explosion-proof" designs are not hermetically sealed. The clincher is the salt atmosphere generally encountered 30 miles or more inland from sea coasts.

Thus the Illinois motor might get by with a standard material in the ventilating fan while its Gulf Coast counterpart will need a bronze or micarta fan and perhaps other modifications to resist corrosion. Also, if the unoccupied space within the motor housing exceeds 115 cu. in., special arrangements may be necessary to prevent moisture condensation during motor shutdowns.

This is not the place to take sides in the controversy over the matter of ordering control equipment simultane-

ously with the motor in new applications. But for the sake of expediting early operation there should be a word of caution: If the buyer knows he will need new controls for the just-ordered motor, better compare delivery dates for both. Otherwise his plant may find itself with a nice, new motor, all neatly connected to the device it is to drive —but nothing to control it with.

Guaranteed ways to foul up delivery dates are insistence on special features and subsequently inserting changes after the original order is placed. Often the feature which makes the motor a "special" to the manufacturer could be easily taken care of by the buyer in the field. These include unusual mounting arrangements, special shaft connections and the like. Order "specials" only when field changes are impractical, motor manufacturers advise.

Changing specifications after the order is placed, according to one manufacturer's explanation, not only jumps the cost but may materially extend deliveries. The chain of events works like this: When the change order is received, the order department promptly stops production on the current order, then routes the change to engineering. There it may be a week before the new drawings and manufacturing specifications are ready for the production department.

Then production checks the status of the original order, discarding at the customer's expense any already fabricated parts of a "special" nature which cannot be re-used. The changed order is re-entered as if it were a new one in the manufacturing schedule. This delays receipt of the motor, not by just the amount of time consumed between receipt of change and receipt of new manufacturing orders by the order department, but generally by the *total* elapsed time between receipt of the original order at the factory and receipt of the latest revised manufacturing orders by the production department.

Another common way to delay deliveries by up to a week or so is the matter of bearings. Some manufacturers offer a given range of motors having the option of bearings in sleeve or ball types with choice of oil or grease lubrication. The buyer also may select either field-greasable or factory-sealed ball-bearings. Failure to specify the exact type of bearing in the absence of a stated manufacturer's standard is guaranteed to cause a delay until a choice is elected.

Also in connection with the subject of bearings are two other points which may at times cause misunderstandings. Within recent years the major bearing manufacturers have developed standards of physical dimensions and load ratings which will permit interchangeability of various makes in a given size and type. Nevertheless, the motor buyer may perhaps prefer for parts inventory reasons that bearings of a certain make be used. Most electric motor manufacturers will not allow the customer to select bearing makes except in ultra-special cases, because this plays hob with factory parts inventory and procurement arrangements, and converts an otherwise standard order into a "special."

The second applies more to replacements than new motors, and this involves a reportedly more conservative load rating of bearings than was previously customary. Thus, in his new motor, the buyer may find in borderline cases that a given motor has larger or more bearings than formerly. Also this should be noted in making maintenance replacements.

The matter of protecting motors against mechanical failure is receiving increasing attention. This excludes failures due to careless or faulty maintenance, such as proper lubrication and cleaning of air passages.

Along the Gulf Coast, even in the oil fields where conditions normally would not warrant installation of a more expensive motor than the standard splash-proof type, most manufacturers say a long-term saving will result through purchase of totally-enclosed motors. The same applies in such plant applications as cooling tower installations, where hazard conditions normally may not warrant the explosion-proof design.

The reason for the saving is that the totally enclosed design inherently provides less opportunity for moisture and air-borne salt to enter vital parts of the motor when it is shut down. Where a corrosive environment also exists, as often is the case in chemical plants, external parts of the motor may be suitably protected through the use of alloy metals, inert coatings or both. Likewise, where corrosive fumes are particularly prevalent, some manufacturers will provide a so-called "chemical insulation," lead heat exchangers and other refinements to give longer service life.

Manufacturers point out that, where the life of one of the open-type motors is short by reason of mechanical failure (i.e., an electrical failure is here considered as failure to carry rated load, be unsuitable for required torque characteristics or some other reason inherent in electrical design), the cost of just *one* rewind job will more than cover the price differential between the splash-proof and totally enclosed designs. This does not consider lost productive time or tear-down and reinstallation costs.

The matter of costs makes logical the consideration of the three common types of motors found in refineries and chemical plants: explosion-proof Class I or II, totally-enclosed (also fan-cooled) and open types (splash-proof and drip-proof).

Obviously in hazardous areas the National Electrical Code Article 500 (National Fire Protective Assn.) and insurors will require explosion-proof design in the applicable class and group. However, there are often locations where totally-enclosed designs are equally acceptable. From the practical standpoint, the explosion-proof design has closer fits for machined surfaces and there are more bolts in the bolt-circle.

Naturally, the motor manufacturer cannot accept the responsibility of determining the applicable hazard for a buyer's plant. Also, the buyer often may find it expedient for reasons of inventory control, plant safety or interchangeability of spare equipment to specify only motors and accessories meeting the most severe hazard requirements. However, where these conditions are not controlling, the buyer can save money by avoiding explosion-proof motor designs and wiring circuits.

A look at comparative costs is illuminating. Consider a common size of plant motor for a centrifugal pump: 75

Here It Is Again

Almost two years ago when this series began on "How to Order Equipment" it was our intention to limit the subjects to more common types of equipment—valves, pumps, heat exchangers, and the like. Interest was so great, however, that we asked Dave Thornton, the originator, to poke around and see what else he could come up with. For example, readership surveys showed there was a need for similar tips on buying cooling towers. So last summer, Dave put one together on that subject. Another need was for one on motors. And here it is. You can look for still more in the future, as fast as material can be assembled.

hp., 440 v., 3 phase, 60 cps., 3600 rpm. with normal starting torque (NEMA Design B). The explosion-proof motor costs approximately $150 more than the totally-enclosed fan-cooled (TEFC) design. The TEFC motor similarly is $600 higher than a splash-proof design. These are based on one manufacturer's current price list for "large user" class and are electrically identical, but they illustrate the point.

Some buyers may not realize the inherent restrictions which enclosed and explosion-proof designs place on the ability of the motor to withstand overloading, especially on continuous duty. This develops from the unavoidably poorer ventilation which must be lived with in the enclosed types. The usual open motor, with its 40°C rise, normally is capable of taking up to 115% of its rated load without turning a hair. Depending on the application, it can take proportionately higher loads in intermittent operation.

This is not so for the enclosed motor. That 50 or 55°C rise stamped on its nameplate means it has *no* overload capacity for practical purposes. Therefore, especially in these types, it is very foolish to specify a motor "right on the nose" with the horsepower requirement of the driven device. If there is any doubt, motor manufacturers urge selection of the next larger size; the very minor cost difference will be but a drop in the bucket compared to the probable rewinding bill. Moreover, since the electrical efficiency curve of a motor is practically flat between 75 and 100% of rated load, there will be no discernible operating cost penalty with the bigger motor.

To double-check against this very possibility, motor manufacturers usually like to know the application. They are particularly concerned with the motor size when the application is known to be one where an overload could occur. Take, for instance, the case of a centrifugal pump in an application where the discharge pressure might drop due to process upsets. Should this occur, volume would increase and the power demand would go up proportionately. In this instance the motor manufacturer would recommend (if he knew all the facts) a larger size motor to minimize a potential outage from overload.

Many buyers fail to advise the direction of rotation on motors, an especially necessary bit of data for enclosed designs in any but the smallest sizes. While from the electrical standpoint reversal may be accomplished by manipulating lead connections, in large motors or enclosed designs the fan may neither provide adequate air-circulation if rotation is reversed nor is there room to physically reverse the fan on the shaft. The proper way to state rotation is "counterclockwise *facing* the end opposite the drive," or coupling end.

It is advisable to tell the manufacturer when the specified motor is to be installed in *any other* than the normal position because of the design of lubrication means or the thrust loads which may be imposed.

When vertical motors are involved, and usually this is a pump application in the oil and chemical industries, it is very necessary for the manufacturer to be advised of thrust characteristics. This should state, in pounds, the amount of thrust and its direction. In a centrifugal pump the starting thrust may be upward, while the operating thrust will be downward and of different magnitude. The motor bearings also may be called upon to support the weight of the rotating member of the driven machine. The buyer should secure this information from the manufacturer of the device to be driven.

Another thing which electric motor manufacturers wonder about, with respect to purchasers of explosion-proof equipment, is how safe are the wiring circuits themselves and especially enclosures for control equipment, junction boxes and the like. Are these as safe as the motors from the explosive standpoint?

Many people believe they have explosion-proof facilities when actually they do not. It once may have been explosion-proof but is no longer. This may in part stem from careless or inadequate maintenace but more commonly because the *supplier* of the switchgear enclosures and the like was unable to tell from the order whether or not the installation was indoors or outdoors. Another less-common contributor is misunderstanding or overlooking of some of the National Electric Code requirements for hazardous locations.

As a case in point, suppose the cover of an explosion-proof enclosure is not tightly bolted down—maybe just one bolt is not tight. Experiments with explosive mixtures within and without the enclosure indicate that, should an internal explosion occur, just one loose bolt might very well permit flame propagation *beyond* the enclosure and thus become a potential ignition source.

Where the enclosure is covered by a threaded cap or cover it should be finger-tight.

The National Electric Code states in part (underlining supplied):

"Safety of use in hazardous locations will be endangered should openings or other alterations be made in the devices. *Holding bolts* of enclosing cases and threaded parts must be screwed tight. Continued safety of installation will depend on proper maintenance. This equipment is intended for use indoors where severe corrosive conditions are *not likely* to be present."

Unfortunately, the term "holding bolts" in the above Underwriters' statement is confusing, as in the electric industry this really refers to "ground-joint construction." Screw or bolt-held covers is ground-joint construction; specifically, wall switches, motor starter housings, junction boxes and junction boxes on electric motors.

It is recommended that every user of explosion-proof equipment should check both new and old items of ground-joint construction with a feeler gage. If an 0.015-in. gage can be inserted at any point, the enclosure may be no longer explosion-proof. If, however, it will accept a feeler gage 0.010 in. thick, the device likely is still safe.

It is suggested that every purchasing authority down to the point where the requisition originates should positively verify whether or not the installation is to be inside or outside, and if humidity moisture and corrosion are to be expected. For outside installation and inside wet or corrosive applications, the catalog item description should be checked to see that it reads the equivalent of "explosion

proof, dust tight *and* weather resisting." Description reading "explosion proof and dust tight" without further amplification, mean that the item is *not* approved either for outdoor use or indoor wet and/or corrosive conditions.

Provision against moisture condensation—breathing—is equally as important with control and wiring housings as with motors themselves, and the same consideration applies. Where the unoccupied volume exceeds 115 cu. in., it is advisable to install suitable drains and breathers, or make other arrangements to get rid of accumulated moisture.

ORDERING MOTOR CONTROLS

The big problem in ordering controls is for the customer to decide two things which the controls manufacturer cannot do for him. The first is whether or not the motor is to start under reduced voltage or across-the-line. The second is whether it is to be automatic or manual start.

Many buyers, it is believed, may not be aware that most motors may be started across-the-line without damage—providing power supply is adequate. Catalogs always carefully indicate designs incapable of across-the-line starts.

Remember that an AC motor usually draws five times or more its full-load current during an across-the-line start—above 75 hp., and if a large motor, this can amount to considerably more than a momentary "bump" on the line. It could fry substation transformers and melt insulation on intervening lines, throw circuit breakers or trip undervoltage protective devices serving other equipment on the affected circuit.

There is another factor which the buyer may desire to consider in deciding on across-the-line vs. reduced-voltage starts, and that is the power-demand penalty which may be involved. It may develop that, even though power supplier requirements and associated substation equipment safety factors may permit across-the-line starts for a given motor, the starting current required in addition to the existing load may push demand over the penalty level. This penalty cost will have to be balanced against the higher incremental cost of reduced voltage starters.

Manual-start controls normally are less expensive than automatic-start equipment. They cannot be used where starting current is high on across-the-line starters. The manufacturer's catalog should be carefully consulted on this point.

Another way to save installation time and capital expenditure is to consider so-called "combination" controls. The Code requires fusible disconnects or circuit breakers between control and supply feeder, but these need not be in the controller enclosure or integral with it.

However, it takes but little more room to accommodate these required safety provisions (and seals if an explosion-proof assembly) within the control housing. Moreover, the whole sub-assembly is factory-wired, simplifying field installation.

Both motor and control manufacturers always want the customer to tell them how the motor will be protected in service against overloads, overheating and whether provisions for space heating (what kind) are desired. Usually the buyer must decide what the control is to do, as the manufacturer cannot usually determine from the customer's order whether or not it is more important to risk some motor damage than give the motor maximum protection, in the sense of a continuous process.

There are roughly three basic types of overload-sensing control provisions available, along with many combinations and variations. These include current-measuring, reacting when the motor draws excessive current; thermal relay, which is actuated by the differential between motor and ambient temperatures, and the bridge type, which uses resistance as a measure of temperature increase due to overload. All these may be connected through relays to either shut down the motor or sound an alarm.

The control manufacturer also must know the type of motor when supplying protective controls, for reasons inherent in motor characteristics as well as the enclosure employed. One is as important as the other, because totally-enclosed and explosion-proof motors are rated for a 50°C to 55°C (fan-cooled) or more rise in temperature for continuous operation, and splash-proof, 50°C., whereas the open and drip-proof designs have only a 40°C rise over an ambient of, usually, 25°C (77°F).

Thus the thermal overload protective device must be properly selected to afford the required protection. With the 50 and 55°C motors this means the observed temperature of the "hottest spot" in the windings will not exceed 95° or 115°C (203° or 230° F). This must be rather closely watched as it is so near the maximum safe temperature for the insulation that a few degrees more could seriously impair the service life of the winding.

Data Required When Ordering Electric Motors

THE following listing of data to be supplied manufacturers when ordering motors or requesting bids is based on the requirements and recommendations of a number of representative manufacturers. It is split into "vital" and "desirable" information and is intended as a checklist in preparing both requisitions and purchase orders. Use of this list will give the manufacturer a clear picture of the buyer's needs for most motor applications in the oil and petrochemical industries and eliminate call-backs, requests for supplementary information and the like.

Do not mix "special" with "standard" motors on a single purchase order. If changes must be made later in "specials," *some* delay can be avoided.

ELECTRICAL SPECIFICATIONS

Vital Information

A. All Motors. (Power Characteristics.)

1. Voltage, AC or DC.
2. Cycles per second, AC only.
3. Number of phases, AC only.

B. Induction Motors.

1. Type and Horsepower. (Type often signifies motor design. Horsepower should in general equal maximum anticipated requirement of driven machine and under upset conditions if the service is vital. Also give horsepower requirement of driven device. If in doubt, give application details.)

2. Speed and Direction of Rotation
   a) Speed, rpm.
      1) Fixed speed. Advise "synchronous speed" desired (i.e., 3600, 1800, etc.) for A.C. motors. For D.C. motors, advise desired basic speed at full load *and* maximum speed by field control.
      2) Multispeed (A.C. polyphase motors). Specify whether single or dual winding,* the two or

more speeds desired and choice:
(a) Constant horsepower.
(b) Constant torque.
(c) Variable torque.

*NOTE: Certain speed combinations require dual windings, while others may be either one or two. In latter case, compare costs of both motors *plus* their controls.

3) Variable speed (A.C. wound-rotor motor).
(a) Maximum speed.
(b) Number of "steps" of speed control.
(c) Speed at each "step" (or allow motor manufacturer to select from performance data for driven machine).
(d) Performance data on driven machine (i.e., torque requirements from design data curves on pump, centrifugal compressor, blower, winch, hoist, etc.) Specifying NEMA design for motor, under "torque," below, may be omitted if design curves are furnished.

b) Gear motor. So specify and state output shaft speed or speeds as above. Also specify class of gear as follows:
1) Class I gear—not over 8-10 hrs/day: *no* shock loads.
2) Class II gear—over 8-10 hrs/day *or* shock loads
3) Class III gear—over 8-10 hrs/day *and severe* shock loads.

c) Direction of rotation. State reference point. (Example: "clockwise facing the end opposite drive" or coupling end.) If service to be reversible via control, so state.

3. Torque. Specify NEMA design (A, B, C, or D) or manufacturer's designation if known. For special applications, advise when load peaks occur and severity, starting, pull-in, and maximum torques. For fractional hp., some manufacturers give choice of capacitor-split phase, reactance-split phase or repulsion-start.

4. Locked rotor current (especially for fractional hp. motors) Specify National Electrical Code rating (NFPA). (Should not exceed "H," or 7.09 KVA/hp for high quality motors. Advise if nameplate to be code-stamped. Large motors usually so marked.)

5. Application. (Very necessary for "special" motors and desirable for all others; especially large motors driving centrifugal and reciprocating pumps and compressors. Advise if these start under load. If a replacement and previous motors have failed frequently; give all details, as reconsideration of electrical specifications is in order).

C. Synchronous Motors. These are normally used only when speed constancy is important, "power factor correction" is desired, or application is very low speed.

1. Section A and Items 1 and 2, Section B, above.

2. Advise exciter power characteristics available, or specify manufacturer to provide required exciter (small synchronous motors may use permanent magnets) as: direct-connected, belt-driven or motor-generator set.

3. Torque. Specify required starting, pull-in, pull-out and maximum torques.

4. Complete application details and data on driven machine usually required by most manufacturers.

Desirable Supplementary Information, all motors.

A. Protective provisions if not to be provided by usual overload device in controller. (Manufacturer may make recommendations based on application details.) Buyer may specify.

1. Special temperature-sensing windings or elements; always optional with customer. These may be thermocouples embedded in the winding, listed under various trade names, or resistance windings, operating through motor control device. Advise if contacts to be normally open or closed and whether to operate alarm or shutdown motor. In fractional horsepowers these are often bimetallic strips interrupting power supply and resetting automatically or manually.

2. Heating element for moisture protection. Specify:
a) Embedded in coil or,
b) Installed within motor enclosure.
c) Power characteristics available or to be provided for operating a or b.
NOTE: Some manufacturers do not supply such provisions; see catalog or contact representative.

3. Insulation. (Normally specified for "tough" environments.)
a) If requirement known specify NEMA Class (A, B and H or manufacturer's special catalog options. Some manufacturers require special application information when NEMA Class H is specified.
b) High-temperature service (advise anticipated maximum ambient temperature).
c. Chemical resistant. (For marine and coastal applications; chemical plants; locations where abrasive dusts are common; high humidity inland locations where motor duty is cyclic indoors or outdoors. Some manufacturers supply so-called "special Class A Gulf Coast insulation," "chemical insulation," etc.; others do not.)

B. Starting provision. (While most normal motors now are capable of across-the-line starts, some designs are not; check catalog carefully on this point and specify requirement if different.)

C. Performance characteristics. (Usually includes following electrical characteristics: efficiency, power-factor, locked rotor KVA, full-load speed, temperature rise and starting, break-down and full-load torques.) Be sure to advise if special test certification to be furnished; this *always* extends delivery time and increases cost.

D. Replacement motors. (Advisable to state why original motor failed, especially if an electrical failure. Give details for manufacturer's study and recommendation.)

MECHANICAL SPECIFICATIONS

Vital Information.

A. Enclosure.

1. Hazard. Specify explosion-proof and always class and group (i.e., Class 1 Group D for most petroleum refinery applications).

2. Protective. Options are: open (no protection), open drip-proof, splash-proof, totally-enclosed, forced-ventilated, self-ventilated, and sanitary.

3. Advise if corrosive conditions preclude use of standard materials in motor construction.

B. Bearings. See catalog only as to options and manufacturer's standard as to grease and oil-lubricated ball and sleeve bearings, also forced-feed. *Do not specify* size and make of bearing, or factory-filled lubricant.

C. Mounting.

1. Standard. Advise mounting position: vertical, horizontal, wall, etc. (Some motors cannot be mounted other than horizontal because of bearing and/or lubrication arrangements without special provisions. Others are universal mount and still others can be suitably modified in the field.)

2. Flange. Advise type; see catalog: Specify horizontal or vertical position.

3. Vertical hollow-shaft. (Usually a pump application.) Some manufacturers prefer these to be ordered through manufacturer of driven machine due to complex requirements.

4. Special. Advise requirements in detail; manufacturer may have an available standard ordinarily unlisted.

D. Shaft Connection. (See catalog.)

1. Specify type: direct (specify type and make of coupling, keyed or screwed, and whether or not manufacturer is to supply), and single or double-ended; spiral threads, supplying details; V-belt or flat-belt sheave.

2. Shaft extension. Specify only for special applications; note catalog dimension data before ordering.

3. Special connections. Consult manufacturer.

E. Thrust and unusual bearing loading.

1. End-thrust. Advise magnitude in both directions, such as in centrifugal pump applications, especially when motor is vertically mounted. Application details, when furnished, usually give a clue to whether or not these data are required.

2. Lateral thrust. Advise only in cases of unusual bearing loads.

F. Duty.

1. Continuous or intermittent operation.

2. If intermittent duty is it occasionally overloaded.

G. Environment.

1. Location, inside or out-of-doors; is location damp or humid; is water likely to drip or splash on motor.

2. Maximum air temperature (advise if sun shines on motor).

3. Presence of corrosive fumes or liquids; specify nature.

4. Dusts; present or absent. If present, state nature—corrosive, abrasive, or flammable.

Desirable Supplementary Information.

A. Breathers and drains.

1. Specify when option given in catalog (some manufacturers do not supply these).

2. Standard or explosion-proof.

3. Material of construction (under corrosive conditions).

B. Frame size. (Usually applicable only when ordering replacement motors or for special applications. Size usually must be at least as large as manufacturer's standard for motor size and speed.)

NOTE: Beginning in 1954, NEMA Standard frame size will be one number smaller for motors of 1 to 3 hp. than previously, due to improvements in insulation requiring less space for wiring. It therefore will be advisable in ordering replacements in this range to state whether or not driven equipment was sized to take the former standard frame for this horsepower.

C. Nameplate material. (Specify stainless steel when standard brass will not resist anticipated corrosion.)

D. Fan material. (Normally may be left to manufacturer if environment—Item 7—details are supplied. Otherwise advise brass, high silica, bronze, aluminum, "textolite" or micarta, etc.).

E. Special frame or mounting construction. (Consult manufacturer.

F. Nameplate data. Advise if Locked Rotor KVA and Underwriter Code stamps required.

G. Certified drawings. Advise if required and to whom supplied.

H. Special shipping instructions.

ORDERING REPLACEMENT PARTS

A. Nameplate data. Give ALL nameplate data, regardless of how inconsequential it may seem; the manufacturer is virtually helpless without it.

B. Use name, number or other designation in parts list, as well as naming part.

C. Bearings. Most bearings are standard as to dimensions, and may be ordered from the bearing manufacturer. (Note: Within last few years motor bearing ratings have been changed, generally towards reduced rated loads.)

Data Required When Ordering Controls for Electric Motors

IT is advisable to order controls from your favorite source at the same time the motor to be operated is ordered (unless it is a replacement and you will use the old controls), or as soon thereafter as necessary information is available. This is because delivery of at least some controls is as long or longer than the "lead time" for motors. Besides, ordering the controls may be overlooked.

Even if the controls are ordered through the motor manufacturer (who may or may not make them, too) it is preferable not to include them in the same purchase order with motors, wiring, electrical fittings and the like. This is because a "shotgun P.O." must be broken down into the different classes of items involved, checked and then routed. If only one item class is involved, routing is routine.

As suggested for motors, "special" controls should be on separate orders from "standards" unless there is a

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valid reason to lump them. This will assure delivery of "standards" whether or not there is a delay of some kind on the "specials."

A. All Controls.
  1. Power Characteristics.
    a) Voltage, AC or DC.
      1) Motor supply.
      2) Other available supply (applicable only when space-heating protection is to be used with 440 v. and higher motor supply.)
    b) Frequency, cycles per second (AC only).
      1) Motor supply.
      2) Other available supply (see Item 1 a 1).
    c) Number of phases (AC).
  2. Motor requirements.
    a) Horsepower.
    b) Full load amperage.
    c) Torque classification (or give motor type and manufacturer).
    d) If a "special" motor, provide data given motor manufacturer or authorize him to supply required information.
    e) Motor enclosure. (I.e., open or totally enclosed.)

B. General Control Information.
  1. Type of starter, if known (catalog designation) or fully describe required control function.
  2. Type of Start. Specify full or reduced voltage:
    a) Full voltage.
      1) Manual. (Usually 5 hp. 220 v. or 7½ hp. 440 v. and smaller motors.)
      2) Magnetic.
      3) Remote. (Specify if by float, pressure or via relay. If relay, power output data required.)
    b) Reduced voltage.
      1) Manual.
        (a) Resistance.
        (b) Reactance.
        (c) Autotransformer.
      2) Magnetic.
        (a) Resistance.
        (b) Reactance.
        (c) Autotransformer.
  3. Control Action.
    a) Start and stop.
    b) Hand-off-automatic (H-O-C).
    c) Multispeed. Specify:
      1) Specify speeds, two or more.
      2) Continuously variable. Advise speed range.
    d) Reversible or non-reversible. (Usually applicable to machine tools in oil and chemical industries.)
  4. Special features.
    a) Motor protection.
      1) Overheating. (Advise if temperature-compensation necessary and anticipated maximum ambient temperatures at motor and control locations.)
      2) Over and/or under-voltage.
      3) Circuit-breakers or fusible-disconnects integrally-mounted. (Sometimes called "combination starter.")
    b) Moisture protection.
      1) Space heaters (only if motor so-equipped).
      2) Coil heating current.
    c) Other special features. (Specify.)

C. Control Enclosure.
  1. Location. Specify:
    a) Outdoors (advise if surroundings corrosive and necessary details).
    b) Indoors (advise if location likely to be damp or humid, corrosive, etc.).
  2. Hazards (explosion-proof, dust-proof, etc.).
  3. Oil- or air-immersed. See catalog. (Usually manufacturer supplies air-immersed if customer does not specify; *may* suggest oil-immersed control if he believes environment warrants it, but buyer should not depend on this.)

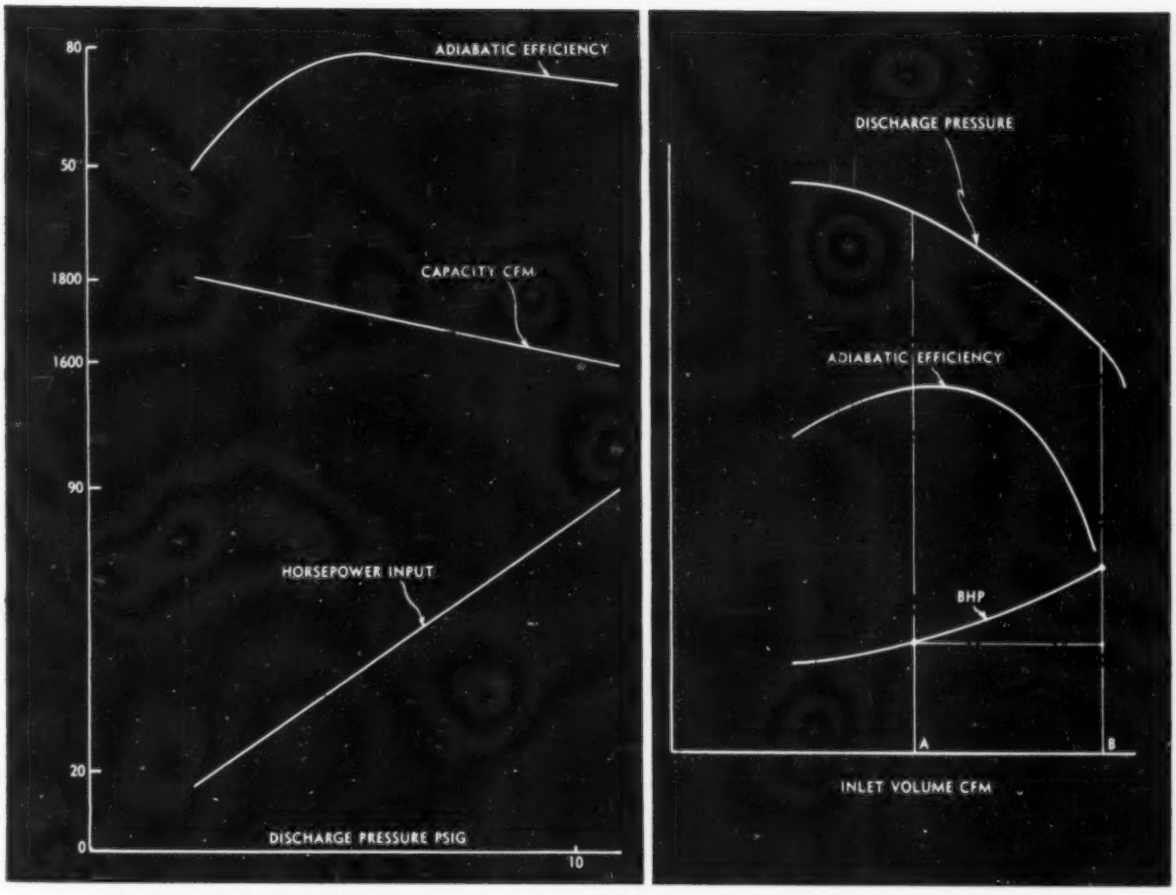
Summary of Vital Information Required For Most Motor Orders

(*Squirrel-Cage Induction Motors*)

Motor manufacturers say information in this list will cover about 90% of motors ordered by the oil and chemical industries since, very often, they can "read between the lines" from experience. This does not include such types as vertical solid- or hollow-shaft, gearmotors, synchronous, dual-speed and wound-rotor motors, generally ordered less frequently.

A. Power Characteristics.
  1. A.C. Voltage.
  2. Frequency.
  3. Number of phases.

B. Motor Requirements.
  1. Enclosure. (Specify: open; drip-proof; splash-proof; totally-enclosed, or explosion-proof with class and group.)
  2. Horsepower.
  3. Speed. (Specify a single, synchronous speed.)
  4. Direction of Rotation. (Give reference point.)
  5. Starting torque. (Specify normal or high, also low or normal starting current or NEMA Design A, B, C or D.)
  6. Bearings. (Specify ball or sleeve when option given; also grease or oil lubricated.)
  7. Shaft size and extension. (Specify *only* if other than catalog standard.)
  8. Locked Rotor KVA and Code Stamp. (Optional.)
  9. Provision for corrosion and moisture protection. (Optional.)
  10. Application (Optional but desirable.)



CHARACTERISTIC PERFORMANCE CURVES for positive displacement blowers (left) and centrifugal blowers (right)

What Type Blowers Do You Need?

. . . POSITIVE DISPLACEMENT OR CENTRIFUGAL

By HAROLD W. WOODHOUSE
Chief Engineer
Dean Hill Pump Company

ARGUMENTS for selection of either a positive displacement or a centrifugal blower do not appear to be well defined although there may be good reasons why one or the other is to be preferred for a particular installation.

Occasionally a user is undecided as to the best selection even after considerable experience. An old established manufacturer of gas and diesel reciprocating engines recently switched from a centrifugal supercharger blower to a positive displacement and then back again to a centrifugal.

Since manufacturers of positive displacement type blowers rarely build centrifugals also, the engineer charged with the choice of equipment for a particular project may have some difficulty in obtaining an unbiased opinion of the relative suitability of the two types.

Positive Displacement Blowers

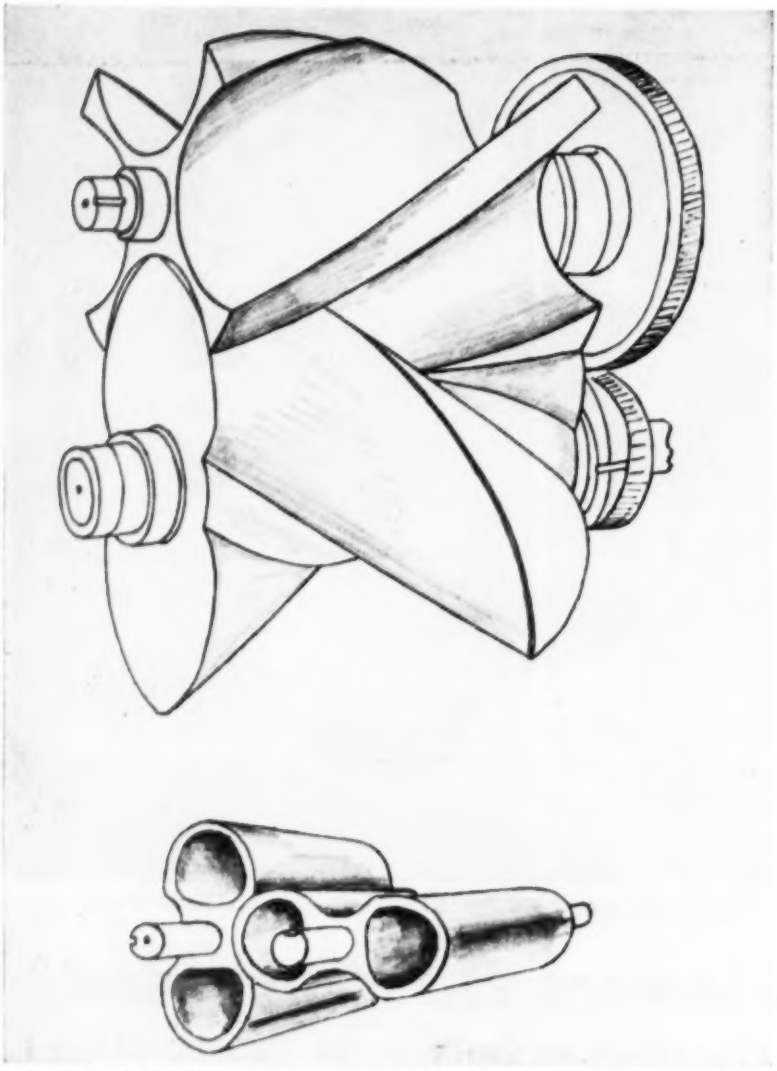
While many different designs of positive displacement blowers are made, only those having lobes machined integrally with the hub enter into serious competition with centrifugals. These lobes are either straight, as in the lower part of the illustration on page 1326, or helical, as in the upper part of the same drawing.

They are positive displacement in that they deliver a measured volume for each revolution regardless of the suction and discharge conditions, neglecting the modification due to slip.

This is one of the greatest advantages of the positive displacement blower. Regardless of what happens to the piping or equipment on its discharge side, the blower continues to deliver the same volume of air or gas for the speed at which it is operating. It should be noted that the volume, referred to inlet conditions as is standard practice, will vary slightly, say to a maximum of $\pm 15\%$ due to change of pressure affecting the slip coefficient. This is shown by the almost horizontal nature of the curve of capacity versus discharge pressure in the characteristic curve graph above.

So, there will not be a tremendous volume flow through the blower as would be the case with a centrifugal blower should the discharge pressure drop much below the designed operating point.

In other words, the positive displacement blower "meters" the flow



POSITIVE DISPLACEMENT BLOWER LOBES may be of two types, helical (at top) or straight (below)

in such unforeseen circumstances. This is of some importance in installations where a number of different boilers and blowers are integrated into one system.

These positive displacement blowers are frequently advertised as meters and in some instances are bought and installed with this metering characteristic as the prime function. Centrifugals are never purchased as a metering device.

One of the disadvantages, which has its effect on cost, is the considerable amount of accurate machining required to ensure proper meshing of lobes. The absence of any lubrication dictates that the lobes shall run with minimum practical clearances without, however, touching each other or the casing, since, if contact occurs, rapid wear of lobes and casing will result, coupled with increased noise and decreased volumetric efficiency.

This necessitates very accurately machined and set timing gears. The lobes and casing must maintain a rigidity of shape up to maximum working load. They must be thoroughly stress relieved so that aging does not result in a change of shape and cause rubbing contact of lobes and casing.

A disadvantage, particularly with the straight lobed design, is that as each space between lobes, with its new supply of air (or gas), is opened to the discharge line, the pressurized air in the line rushes back into the lobe space, thereby creating a pulsation and noise. A similar condition exists at the suction side where slugs of air are cut off abruptly from the inlet line.

Generating the lobes on a helix is one method of alleviating these conditions. Another is to design the lobes so that there is a progressive compression of the air (or gas) by the lobes so that the air in the lobes is closer to discharge pressure as the discharge port opens.

Occasionally, neither cost, nor weight, nor size, nor operational characteristics curve may be the deciding factor in selection. This is particularly true where the unit is required to operate in a confined space, and where personnel would be exposed for long periods of time to a relatively high noise level. Here, a few decibels in rating would be the overriding factor between centrifugal and positive displacement, or even one make of positive displacement blower versus another.

Some typical decibel ratings for the helical lobe type are:

At Suction	118-120
At Suction with Silencer	91-101
At Discharge, Into Open Room	120-130

The straight lobed type might run 8-10 points higher than the above.

In those cases, then, where noise level is of considerable importance, the positive displacement blower, and particularly the type with progressively compressed air (or gas), has, generally, a few decibel points advantage over the centrifugal.

The older form of positive displacement blower with straight lobes, was a slow speed unit, and could not compete on a basis of size and weight with the centrifugal. Furthermore, it had hardly any advantage in noise level. More modern designs run at higher speeds, so that, somewhat surprising as it may seem, even manufacturers of centrifugals do not generally claim any particular advantage in size and weight for their units over the positive displacement.

An executive of a positive displacement blower firm makes this statement: "Generally, if the CFM capacity is 5000 or less and the pressure is 5 psig. or more, the positive displacement blower will outperform the centrifugal in every department . . . Likewise, the positive displacement blower can compete successfully with the centrifugal in all ranges up to 10,000 CFM provided the pressure moves up to about 10 psig."

As far as efficiency is concerned, there is not much to choose between the two although the positive displacement will generally have the edge in the range in which it is competitive in other respects. As will be seen in the left-hand curve graph on page 1325 it can reach about 78%, whereas, for the centrifugal, the range is more like-

ly to be 65-75% for a typical unit as shown by characteristic curve in the right-hand graph on the same page.

Centrifugal Blowers

In common with other centrifugal types of machinery such as the turbine, centrifugal pump and multi-stage centrifugal compressor, the blower's great advantage is its simplicity. Only in the bearings is there running contact between two surfaces; at all other points there are ample clearances. One or two men can easily and quickly remove a rotor and replace a defective part. Only at the bearings is really fine machining essential. There are no machine generated parts; no lining-up to be done, no fine gears, no timing of rotor, no rubbing troubles from aging distortion of the casing or impeller.

It can be built for tremendous capacities at any desired moderate pressure. Generally, it cannot compete with the positive displacement blower if the capacity is less than 5000 CFM because the losses become too high.

The great disadvantage is that centrifugal blowers cannot operate at a capacity which is less than 35-45% of their designed rate, unless special by-passing devices can be installed, without a condition occurring known as "surging," a pulsating effect which, if long continued, might result in damage to the machine or equipment on the discharge side, and, in any event, causes a wide fluctuation in delivery pressure which is highly undesirable.

To avoid surging in large installations where several units are in operation under normal load conditions, the simplest solution to light load operation is to cut out one or more blowers so the remainder will be loaded to deliver a capacity well beyond the surge point. Otherwise it would be necessary to recirculate part of the blower discharge back to the suction side or arrange for the blower to discharge partly to atmosphere, a wasteful expenditure of energy in either case. Certain other devices are available, all of which woul l increase the cost and complexity of the blower.

Those blower impellers having well backwardly curved blades will have a wider range of operation. This construction may be applied to centrifugals of moderate speed (roughly to 770 ft./sec. tip speed) but higher speeds dictate that radial blades be used to avoid bending stresses. This statement should be modified to say that aluminum impellers with backwardly curving blades are made for slightly higher tip speeds than 770 ft./sec. as gas and diesel engine superchargers, but their capacity is moderate so that the impeller is narrow and the blade bending stresses are held down.

Centrifugals are made in sizes with capacities far beyond those available in positive displacement units. There is nothing unusual in the size of a centrifugal blower which will deliver 120,000 CFM of air at 35 psig. to a blast furnace.

Where an extremely large capacity of air or gas is required the limiting size of the individual centrifugals is generally dictated by the old adage of not putting all one's eggs in the same basket and the desirability of retaining a certain amount of flexibility by being able to cut units in and out as required.

As previously quoted, the centrifugal is considered beyond positive displacement competition when the pressure exceeds 10 psig. Pressure in a centrifugal is a combined function of the rpm., number of stages and diameter of impellers, so that by manipulation of these variables considerable change may be obtained in the designed operating point.

This points up an advantage for the centrifugal. If, after an initial period of operation the load increases in the direction of requiring larger capacity, it can sometimes be obtained merely by changing the impeller or impellers. If the load increase is in the direction of higher discharge pressure, then larger diameter impellers can sometimes be installed or the rpm. increased, or for maximum pressure increase both of these changes can be made simultaneously.

With bearing housings mechanically remote from the impeller casing and with the use of mechanical and shaft oil seals, the centrifugal is without competition in the large refrigeration compressor and corrosive chemical gas fields.

Where a centrifugal blower is motor driven it is often important that the motor be purchased with enough power so it is non-overloading at all conditions of operation of the blower.

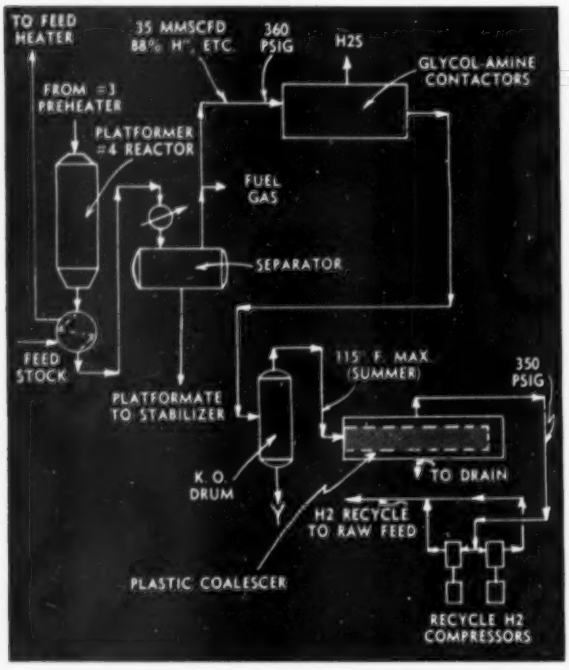
By referring to the curve chart on page 1325 it will be seen that if discharge pressure corresponding to the design point and maximum efficiency, capacity A, is allowed to drop to a value corresponding to a capacity B there is a considerable increase in horsepower required which might result in a burned-out motor if long sustained.

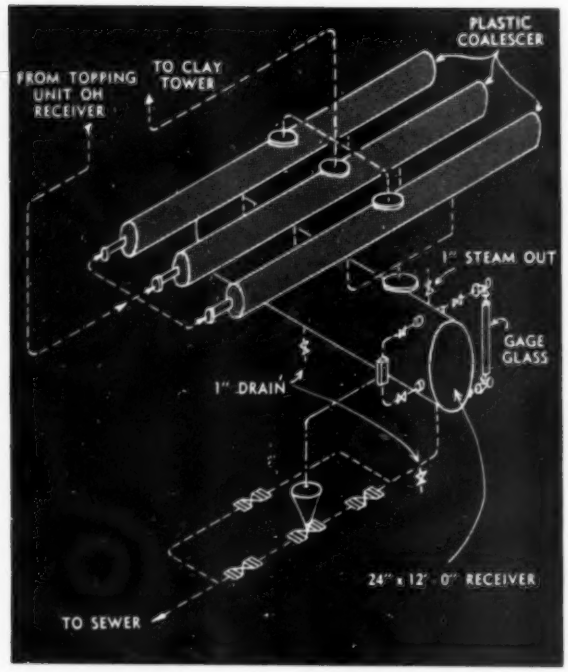
In the final analysis selection of a blower must be determined by one's specific needs. If a few decibels less noise or the metering effect in the event of line breakage are very important, then the positive displacement blower is indicated. If large capacity or high speed direct drive without regard to decibel rating, or if simplicity of design are the factors most desired, then the centrifugal is the best bet.

Meet the Author

Harold W. Woodhouse was educated in England, where he became associated with Fraser and Chalmers, Ltd., manufacturers of turbines and compressors. Coming to this country, he became engineer in charge of development of radial flow turbine wheels and mixed flow compressor impellers for the DeLaval Steam Turbine Co. From 1945 to 1947, Mr. Woodhouse was director of engineering for the Stratos Division of Fairchild E & A Corp., makers of ultra-high-speed air cycle turbines and compressors for aircraft pressurizing and air conditioning. Later he served as general manager and chief engineer of Power Generators, Ltd., where he supervised design of high pressure and temperature turbines and centrifugal pumps for the U. S. Navy

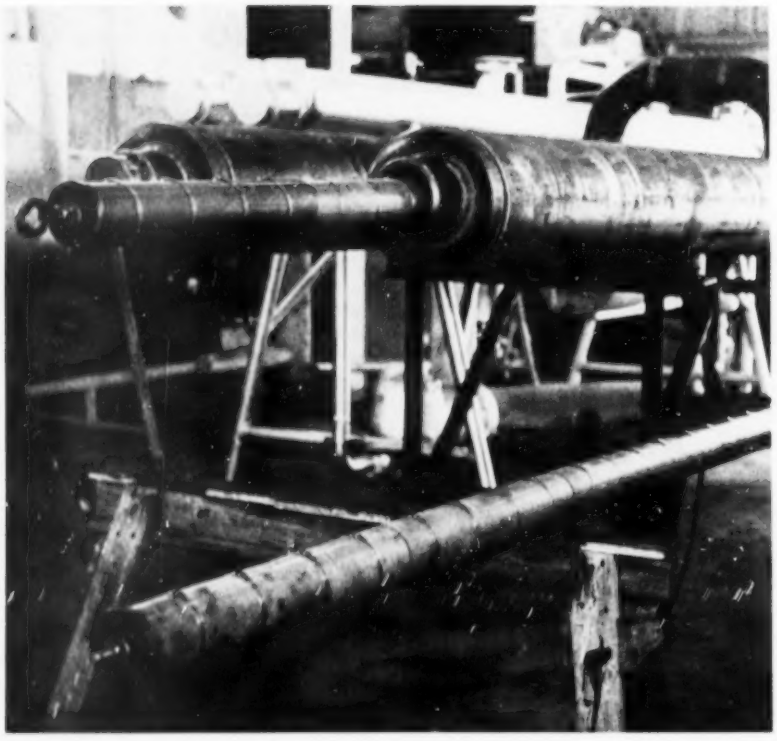
Since 1950, Mr. Woodhouse has been chief engineer of Dean Hill Pump Co., manufacturers of steam turbines and centrifugal pumps. During the same period he has acted as compressor design consultant for Cooper-Bessemer Corp. He is a member of the American Society of Mechanical Engineers, and the American Petroleum Institute manufacturers sub-committee on pump manuals.





FLOW DIAGRAMS, giving location of plastic scrubbers in recycle hydrogen stream (left), and on wet naphtha feed stream to clay towers (right), show how . . .

Plastic Solves Scrubbing Problems



PARTIALLY ASSEMBLED COALESCER unit with one plastic scrubber element half inserted into shell

By D. P. THORNTON, JR.
Southwestern Editor

POROUS, permeable plastic scrubbers, placed in a recycle hydrogen stream leading to a catalytic reforming unit, will take out unwanted liquids satisfactorily.

Engineers at Eastern States Petroleum Co., where this equipment has been installed, are finding the liquid removal cuts down formation of carbon-based abrasives, boosting operating efficiency of the recycle compressors as much as 200%. The principle is not simple filtration, but coalescence of tiny droplets, in this instance entrained treating liquids. The same technique will also coalesce entrained water in gasoline.

The entrainment problem developed primarily because the reforming unit (a UOP Platformer) charge contains varying quantities of sulfur which is converted to hydrogen sulfide during reforming. To prevent build-up of H_2S in the recycle hydrogen stream to the unit which would impair operating efficiency, two tray-type contactors operated in parallel and using a mixture of 15% diethanolamine and glycol in water were installed to remove acid gas and water. The towers

each have a 2-ft. thick "York blanket" to knock back mist and an allowance of 6 ft. from the blanket to the top of the vessel for a disengaging space.

At the tower outlets, the gas stream volume is approximately 35,000 Mcfd. It consists of 88% hydrogen, 2.9% methane, 2.3% ethane, 2.9% propane and 3.9% butanes and heavier. A knockout drum is installed downstream of the towers. The arrangement is detailed in the flow diagram on page 1328.

Despite these precautions, some liquid continued to "come through." This consisted of any hydrocarbons which would condense at the operating temperature and pressure, 115° F. maximum in summertime and 350-360 psig., plus any glycol-amine-water mixture entrained as minute particles. The probability was advanced that entrainment actually was present as "slugs" of liquid, but there is no proof.

That it *was* coming over even if the quantity could not be measured by a wet-test meter and scrubber train is evident from the gummy accumulation of glycol-hydrocarbon-water found on the carbon rings and pistons of the recycle hydrogen compressors after a few days' operation.

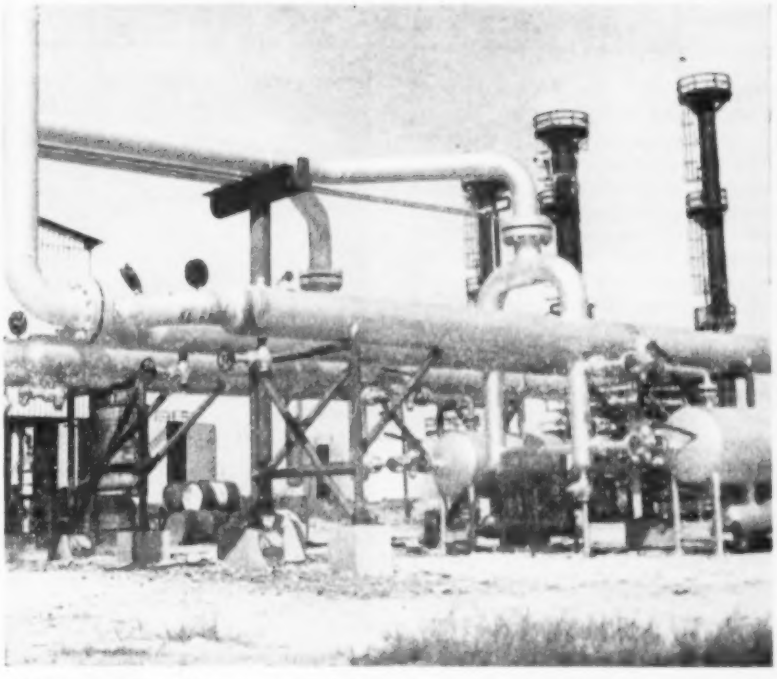
The accumulation inside the compressors was sufficient to require shutdown, at least for inspection, on a seven to ten-day cycle and sometimes more frequently. Rings, valves and even pistons required replacement at an extremely high rate.

Apparently the entrained liquid combined with particles of carbon worn from pistons, rings and valves to make a pasty mass. Remaining in the cylinder, which has a cast-iron liner, the paste acts like jeweler's "rouge" and forms an excellent—too excellent, in this case—abrasive material. Sometimes carbon parts would not last seven days between replacements, the damage being signaled by a loud knock.

From the operating standpoint, this involved reducing charge to the Platformer from the normal 5100 b/d to 3000 or 3500 b/d, time out to shut down and inspect the compressor, and then return the Platformer to normal throughput. Timewise, this amounted to approximately 10 hours. If compressor parts needed replacement an additional two to three hours of lowered production, plus parts and labor, went into the red-ink entry.

A "Petco" scrubber containing an element of porous, permeable plastic was decided upon for trial. Evidence indicated it had been successfully used in the oil fields to remove entrained water from crude oil and also condensate and water from gas streams. Made by the Petroleum Engineering & Tool Co., Houston, the scrubber had been on the market for such uses for the past several years.

The unit was installed on the compressor suction line between the knock-



AS INSTALLED, complete coalescer is shown here removing liquid from a recycle hydrogen stream

SECRET OF SCRUBBER'S ACTION is porous structure of the plastic washer and gasket seal adjacent sections of element

out drum and the compressors as shown in the flow diagram.

The installation, shown in the photo at right, consists of two coalescer assemblies in parallel for each of the two compressors. (The compressors likewise are in parallel, have three cylinders each.) In each filter unit there are nine cylindrical sections of plastic, 4-in. O.D., 2½-in. I.D. and 24 in. long, assembled end-to-end on an iron support member to form a "finger." The "finger" is installed in a 12-in. steel pipe 20 ft. long. Vapor enters the plastic and leaves at the top of the shell-side; liquid drops to an accumulator from the bottom of the shell and is dumped as necessary. The quantity varies between one and three barrels daily.

Immediately upon installation less compressor trouble was evident. Gradually the time has been extended between inspection shutdowns. In one five-month period, not a single ring, valve or piston has needed replacement. The longest operation to date without shutdown for inspection has just been concluded—three weeks and no parts replacement needed. Experimentation will continue until an optimum inspection period has been determined.

Water Removal from Gasoline

In another Eastern States installation, this time in the "old" or No. 1 plant, the plastic coalescers are being used to remove water from gasoline. The results are not as spectacular from an operating and maintenance standpoint, but just as important. Here, gasoline contains from 0.1 to 0.2 vol-% water and some sludge and scale, according to ASTM Standard Test D 95-40.

After it passes the coalescers, the same test indicates water content as 0.01 to 0.02 vol-%. However, Eastern States feels that there is reason to question the test accuracy on the "dried" gasoline. Solubility of water in gasoline and naptha is variously reported as 0.007% and 0.03% in the temperature range 20 to 50° C. If test data are accurate the coalescers apparently are removing some dissolved water under the proper conditions, although it is not expected to be a desiccating agent.

This installation, shown isometrically in the flow diagram on page 1328, consists of three paralleled coalescers accepting, between them, from 3000 to 15,000 b/d of straight-run gasoline (Platformer charge) from the topping unit overhead receiver enroute to clay (Attapulgus "AA" grade) towers for metals (arsenic and copper) removal.

CLOSE-UP of inlet end of coalescer element, showing internal supports and O-ring seal

The three coalescers each consist of a 20-ft. section of 12-in. steel pipe containing a plastic "finger." Each "finger" is made up of ten plastic cylinders, 4 in. O.D. x 2½ in. I.D. x 24 in. long, mounted end-to-end as previously described. Flow is as indicated in the drawing, into the interior of the plastic and out at the top of the shell. Water drains from the bottom of the shell into a receiver to be automatically drained by level control. A connection is available on the shell-side of each coalescer to permit "blowing back" with gasoline or other medium for scale removal in event the plastic becomes plugged.

The manufacturer reports the plastic is a phenol-formaldehyde resin of the "Bakelite" type. In molding the plastic a "filler" material is incorporated in the mixture along with catalysts. After the plastic has "set" this filler is removed, and the molded product baked and treated with a hydrocarbon oil to assure that it will be preferentially wetted by any hydrophobic material with which it may come in contact. This prevents trouble from atmospheric moisture. In some cases the initial wetting agent is a silicone, but this increases cost and normally is unnecessary.

The plastic, it is said, was accidently discovered when an investigator, mixing the fluid plastic with other materials, obtained a solidified plastic whose surface consisted of many thousands of tiny openings, pores, interconnected in such a mnnner as to produce a highly permeable medium. Manipulation of the mixture showed that control of degree of permeability and texture was possible.

Permeability and pore size can be varied to give permeability values ranging from 10,000 to 50,000 millidarceys and a pore size sufficiently small enough to effectively remove liquid and solid particles from five to 50 microns. This explains the coalescing of small immiscible liquid particles and the capture of solids from liquid or gas streams. Preferentially wetted, the plastic will remove water from hydrocarbon streams.

The manufacturer reports a series of tests on raw gas following conventional separation. It was found the plastic coalescer removed from one to five gallons of water and two to five gallons of liquid hydrocarbons per million cubic feet. There also was a pronounced lowering of the dew point of the gas, ranging from 15 to 25°, apparently dependent upon the type of gas. A definite interface existed between the water and liquid hydrocarbon.

The dew-point depression has not been entirely explained. One theory has it that the water exists in the gas stream as a tiny bubble. When the bubble attempts to squeeze through a pore, so to speak, it scrapes off a part of the moisture onto the walls of the pore, which themselves, are hydrophobic. When enough fluid collects, it drips out of the plastic as a liquid.

If this is the case, however, it may also explain the phenomenon noted with wet gasoline at Eastern States. In addition to entrained water existing as droplets, some also may exist as bubbles surrounding small droplets of gasoline. This, then, presumably is scraped off as the gasoline squeezes through the pores of the hydrophobic plastic.

In other tests with 45° API gravity crude and lighter condensates the plastic removed entrained water to 0.03% by volume or less.

The plastic is a relatively resilient material, having a reported compression strength ranging from 3000 to 3500 psi. It may be reinforced with cast-in metal for greater strength. Strong alkalies will damage the plastic but it is generally resistant to acids and alkalies below pH 11. Flow capacity is high and pressure drop low. In general, a coalescer having 20,000 millidarceys permeability will pass 2 gal. water/hr./sq. in. with a pressure drop of approximately 1.5 psi.

How to Use that New Viscosity Standard

By RICHARD H. ROBINSON
Technical Consultant
Fisher Scientific Co.

ON July 1, 1953, the new National Bureau of Standards value for the viscosity of water was officially adopted for the determination of the kinematic viscosity of petroleum fluids by the ASTM's Committee D-2.

What this figure means to the petroleum testing laboratory is, of course, more accurate data on viscosity.

What it also means to the laboratory, on the practical day-to-day level, is a change in the calculating of results. This, however, merely involves —in most cases—one extra step in the calculation. And even this solitary addition is temporary; when all viscometers are re-calibrated and all conversion tables are completely supplanted by those based on the new standard, this extra step will be eliminated.

The main effect of the ASTM adoption of the new, more accurate standard for water viscosity is on the calibration of kinematic viscometers, which is based on the kinematic viscosity of water. The *new* viscometer tubes are calibrated on a basis of 1.0038 centistokes.

Presumably all distributors of kinematic viscometers are now indicating on those tubes supplied after July 1, 1953, that the tubes have been calibrated with the new value. Dr. M. R. Cannon, who pre-calibrates Ubbelohde, Cannon-Fenske and Ostwald-Fenske kinematic viscometers, has stated that all tubes calibrated by his organization are being marked on the outside of the carton as having been calibrated with the new value.

Now the problem comes up: How can I correct data made on the "old" viscometers to have them consistent with the data collected on the "new," more accurate tubes?

Answer: simply multiply the calibration factor (it's supplied with each calibrated viscometer) by a correcting factor of 0.99682. (This 0.99682 is an important figure for the petroleum technician to remember. It was derived by dividing the new base figure for kinematic viscometer, 1.0038 by the old one, 1.0070.)

For collecting viscosity data to be compared with old data, no change in calculation is, of course, necessary; use the old calibration factor.

Shifting to the new standard has one unavoidable disadvantage—when used with an old kinematic viscometer that has been adjusted by the distributor to have a *simple, whole-number* calibration factor. The simple factor *could* be retained, to be sure, even with the new standard value, but this would necessitate moving the calibration mark to a new location.

It is easier to calculate the new (multiple-digit) constant and use it for getting the absolute viscosity values, keeping a note of the whole-number factor for obtaining values that one desires to compare with old, "unreconstructed" data.

Laboratories engaged in *continuous data-collection programs* must, of course, correct all values collected before the introduction of the new viscometers.

However, laboratories confronted with the somewhat stupendous task of converting reams of data collected over several decades may decide to remain on the *old* standard at least until the conclusion of the project. In this case, when using new viscometers bought to replace those lost in normal breakage, technicians must remember to multiply the new calibration factor by 1.007/1.0038, which is 1.0032, to remain on the old basis.

Two other problems, easily resolved, have also resulted from the introduction of the new viscosity standard.

After July 1, 1953, the standard viscosity oil samples of the National Bureau of Standards and the American Petroleum Institute have been labeled with a viscosity value based on the new standard for water. Standard samples still on hand, or shipped before this date, must be corrected to the new standard. Multiply their labeled values by 0.99682.

The other problem concerns only those technicians who wish to *measure* viscosity with a kinematic viscometer but who wish to *report* their data in the widely accepted and understood values of Saybolt Universal or Saybolt Furol "seconds' (also, vice versa, those technicians who desire to translate readings of Saybolt seconds into kinematic viscosity for comparison purposes). The new, complete and corrected conversion tables are published in "ASTM Special Technical Publication No. 43A," available from: The American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

The corrected version of Table XVI from the widely-used "Fisher-Tag Manual for Inspectors of Petroleum" (27th ed.), published by Fisher Scientific Company, for converting kinematic viscosity to Saybolt Universal viscosity, is shown herewith in Table 1.

Table 1—Corrected Version of Viscosity Equivalents

Kin Vis, cs	*Equiv. Saybolt Univ. Vis. seconds* At 100° F	At 210° F	*Kin Vis, cs*	*Equiv. Saybolt Univ. Vis. seconds* At 100° F	At 210° F
2	32.62	32.85	29	136.9	137.9
2.5	34.43	34.67	30	141.3	142.3
3	36.03	36.28	31	145.7	146.8
3.5	37.63	37.90	32	150.2	151.2
4	39.14	39.41	33	154.7	155.8
4.5	40.75	41.03	34	159.2	160.3
5	42.35	42.65	35	163.7	164.9
6	45.56	45.88	36	168.2	169.4
7	48.77	49.11	37	172.7	173.9
8	52.09	52.43	38	177.3	178.5
9	55.50	55.89	39	181.8	183.0
10	58.91	59.32	40	186.3	187.6
11	62.43	62.86	41	190.8	192.1
12	66.04	66.50	42	195.3	196.7
13	69.76	70.25	43	199.8	201.2
14	73.57	74.09	44	204.4	205.9
15	77.39	77.93	45	209.1	210.5
16	81.30	81.87	46	213.7	215.2
17	85.32	85.92	47	218.3	219.8
18	89.44	90.06	48	222.9	224.5
19	93.55	94.21	49	227.5	229.1
20	97.77	98.45	50	232.1	233.8
21	102.0	102.8	55	255.2	257.0
22	106.4	107.1	60	278.3	280.2
23	110.7	111.4	65	301.4	303.5
24	115.0	115.8	70	324.4	326.7
25	119.3	120.1	Over 70	Say sec. = cs X 4.634	Say. sec. = cs X 4.667
26	123.7	124.5			
27	128.1	129.0			
28	132.5	133.4			

PRACTICAL SOLUTIONS TO

Five Common Corrosion Problems

1—Preheater exchanger fins corroded by hot, sulfurous gas oil

2—Caps, trays of topping unit corroded by overly acidic crudes

3—Reboiler tubes pitted by oxidation products, high temperature

4—Eductors on gasoline treaters worn by abrasives, oxidizers

5—Elbows, header in gasoline condenser attacked by hydrochloric acid

1—Poly-charge preheaters

Problem: Fins corroded after nine months service to point where replacement is necessary.

Materials: Carbon steel tubes and fins of an exchanger used as preheater in polyform unit. Fins run the length of the tube (24 per tube) and are 1/32-in. thick.

Process conditions: Hot gas oil containing 1.5 to 1.7 wt. % sulfur enters the fin side of the exchanger at 625-640° F.

Suggested Solutions: While corrosion test data has not been developed to date in a poly-charge preheater, information secured in tests in a vapor separator tower in a gas oil thermal cracking unit, it is believed, indicates the relative suitability of various metals and alloys for the problem application.

These tests were made in the bottom, top and at the tower feed inlet in four refineries of the same oil company, operating under substantially the same process, but with some difference in the gravity and sulfur content of the crudes.

The corrosive effects of sulfur compounds are particularly pronounced on Monel, nickel, mild steel and cast iron at the high temperatures encountered in the polyform units. The austenitic stainless steels, as would be expected, show maximum resistance to corrosion, but the beneficial effects of smaller chromium additions to steel, as in the 4-6% chromium steels, are so pronounced that these materials are usually adequate for towers and associated equipment where elevated temperatures are maintained.

In the tests referred to above, under those conditions that were most corrosive to mild steels, the 4-6% chromium steels showed resistance from 20 to 60 times that of the mild steel. The austenitic stainless steels were substantially free from attack, as were Inconel, Hastelloy A and Aluminum 2S, with one exception for the last named. It seems evident from the data presented that 4-6% chromium steel would represent the most economical investment as a replacement for the carbon steel tubes and fins of the poly-charge preheater in question.

2—Crude fractionating tower tops

Problem: Caps on top Monel tray corroded with perforations in the center section of the tray itself after 2½ yrs. service. During same service period, 10 caps in top tray of 13% chrome steel perforated badly. All nuts and hold down bolts to be renewed because of corrosion.

Materials: Carbon steel shell with Monel lining extending 12 in. above tray level of crude unit fractionating tower. Caps, downcomers and top seven trays Monel, remaining trays 13% chrome steel. (*Table 1 gives the chemical composition of alloys referred to here and in subsequent problems. —Ed.*)

Process Conditions: Corrosive—light naptha and water bearing H_2S and HCl neutralized by the addition of ammonia to pH 6.5-7.5; temperature, 80°-110° F. (Avg 95° F.); pressure, 10 psi; aeration, moderate, agitation, slight.

Suggested Solutions: The difficulty encountered with Monel in the first part of the problem application would seem to be associated with the method of injection of ammonia for the purpose of neutralizing the hydrochloric acid present.

A similar situation was recently brought to our attention wherein ammonia was added to the overhead product and then refluxed back to the top tray. A highly acidic aqueous layer developed on the top tray and accelerated the corrosion of Monel to the point where the thickness of 16-gauge caps and trays was reduced one half in 6 months. Apparently not enough ammonia was used to effect neutralization or else

Table 1—Nominal Chemical Compositions of Metals and Alloys Referred to in These Problems

Material	Nickel %	Copper %	Chrom. %	Iron %	Moly. %	Silicon %	Mang. %	Carbon %	Zinc %	Other %
Monel	67.0	30.0		1.4		0.1	1.0	0.15		
Nickel	99.4	0.1		0.15		0.05	0.2	0.1		
Inconel	78.5	0.2	14.0	6.5		0.25	0.25	0.08		
18-8 stainless steel (type 302)	8-10		17-19	Bal.		0.75*	2.0*	0.20*		
18-8 stainless steel (type 304)	8-10		18-20	Bal.		0.75*	2.0*	0.08*		
18-8 Mo stainless steel (type 316)	10**		16**	Bal.	2-3	0.75*	2.0*	0.08*		
14-18% Cr steel (type 430)			14-18	Bal.		1.0*	1.0*	0.12*		
10-14% Cr steel (type 410)			10-14	Bal.		0.75*	0.60*	0.15		
4- 6% Cr steel (type 502)			4- 6	Bal.	0.45-0.65	0.50*	0.5	0.15		
10-30 copper-nickel	30.0	70.0								
Admiralty brass		71.0							28.0	Sn 1.0
Copper		99.9								
Silicon bronze		96.0				3.0	1.0			
Red Brass		85.0							15.0	
Yellow brass		65.0							35.0	
Chemical lead										Pb 99.9
Hastelloy A	53.0			22.0	22.0	1.0	2.0			
Hastelloy B	60.0			6.0	32.0	1.0	1.0			
Hastelloy C	51.0		17.0	6.0	19.0	1.0	1.0			W 5.0
Illium G	60.0	4.0	21.0	6.0	6.0	1.0	1.0			W 1.0 Al 99.0**
Aluminum 2S										
Ni-Resist (type 1)	13.5-17.5	5.5-7.5	1.75-2.50	Bal.		1.0-2.5	1.0-1.5	3.0*		
Ni-Resist (type 2)	18-22	0.5*	1.75-2.50	Bal.		1.0-2.5	0.8-1.5	3.0*		
5% Ni steel (SAE 2512)	4.75-5.25			Bal.			0.3-0.6	0.10-0.20		
Mild steel				Bal.			0.3-0.5	0.20*		
Cast iron				Bal.		1.5-2.5	0.5-1.0	3.0-3.5		

**minimum value, *maximum value

the ammonia flashed off, with the result that there was no carry-over during refluxing and the pH of the aqueous layer was not thereby increased.

One remedy that has been used with good effect is to inject the ammonia at a point lower in the tower, say at about the third tray. This practice has resulted in markedly decreasing the corrosion of Monel by more effectively neutralizing the acidity of the crude.

Another remedy that is frequently used is to inject the ammonia not only into the top tray reflux but also at the tower feed inlet. In one instance on record where ammonia was injected both into the crude and the top tray reflux to control and hold the pH of water taken from the gasoline separator at 8.5 average, the corrosion rate of Monel was only 0.0037-in. penetration per year.

It might be pointed out that some danger exists with the use of Monel in contact with ammonia where it is in aqueous solution and in a concentration above about 3% NH_3. However, this condition is not generally encountered in crude topping service unless excess ammonia is added to over-neutralize the product.

In connection with the second part of the problem dealing with corrosion of the caps on the top tray of 13% Cr steel, it is believed this is due to attack by hydrochloric acid. Apparently this tray is in the zone of the tower where the temperature of the gases is below the dew point and condensation occurs with the formation of hydrochloric acid. Plant corrosion tests on various types of steel and other metals in the tops of crude topping towers in a number of refineries have shown that the 13% Cr steel in such locations is susceptible to severe pitting attack and a high rate of corrosion.

On the other hand, test data on specimens located in the bottoms of crude topping towers, where temperatures are above 500° F. and little opportunity is provided for condensation to occur, indicate a satisfactory degree of performance of 13% Cr steel.

It seems logical, in connection with the problem application, that, since the top tray constructed of 13 Cr steel extends into the zone of gas condensation, Monel might be used for this tray in addition to the seven trays immediately above.

Generally speaking, corrosion in the top sections of atmospheric crude distillation units arises chiefly from hydrochloric acid either formed by hydrolysis of chloride salts, especially calcium and magnesium chloride, entrained in the crude or added by the acidizing of wells. Despite the customary practice of settling the salt water from crudes, and in some cases the use of special desalting processes, there still appears to be enough salt water dispersed in such crudes to result in an acid condition.

Corrosion is mitigated in some in-

These are answers to five questions on processing unit corrosion originally presented by refinery engineers at a conference in Montreal in 1951. The material presented is taken from part of a paper prepared for PETROLEUM PROCESSING by John F. Mason, Jr., Corrosion Engrg. Section, Development & Research Dept., International Nickel Co., 67 Wall St., New York 5, N. Y.

Detailed reports on plant corrosions tests on problems 1, 2 and 5 referred to in the text, are available by writing Mr. Mason.

stances by injection of ammonia into the distillation system to neutralize part of the acid, but this frequently is not an adequate solution.

It is probably that, with salty charging stocks, maximum hydrolysis of magnesium and calcium chlorides occurs in the hottest region at the bottom of distillation towers. However, maximum acid corrosion occurs in the top portion of such towers, in reflux and distillate condensers, coolers and accumulators, and in reflux and rundown lines, where temperatures are low enough for an aqueous acid phase to condense.

Maximum corrosion by sulfur compounds, on the other hand, will occur in the higher temperature ranges in the bottom portions of distillation towers and in crude heaters. As the alloys most resistant to acid corrosion frequently are not resistant to high temperature sulfur attack, it is common practice to line the top and bottom portions of distillation towers with different materials, to obtain most favorable performance.

From accumulated plant test data, it is indicated that, in general, Monel is the most resistant material from the standpoint of resistance to both general corrosion and pitting under the acidic conditions. It is being used to a considerable extent as a lining, or as a Monel-clad steel shell for upper tower sections, reflux and distillate accumulators and condenser shells, and in some cases for reflux and rundown lines. It is also used for fabricated bubble caps, plates and fittings in upper tower sections.

3—Amine gas plant reboiler tubes

Problem: Pitting attack after 16 months in diethanolamine service and only 4½ months in monoethanolamine service. Holes in both instances most predominant in vicinity of juncture of tubes with tube sheets and baffles.

Materials: Carbon steel tubes (0.095 in. wall), tube sheets and baffles.

Process Conditions: Exchanger used as a reboiler on an amine regenerator. Amine circulated through shell side and steam is passed through the tubes. Amine reported to contain small amounts of H_2S and CO_2; temperature raised to 245-250° F., using 60-65 psig, 20° superheated steam.

Suggested Solutions: Corrosion of equipment, particularly heat exchanger and reboiler tubing, has been a serious problem in some amine gas purifying process plants, while in others little difficulty has been experienced. These plants normally are constructed entirely of mild steel and cast iron. A number of corrosion tests have been made in operating ethanolamine absorbers and reactivators in the presence of varying amounts of H_2S and CO_2 in hydrocarbon gas. The data in Table 2 will serve to indicate the expected performance of different metals and alloys under the particular conditions of exposure.

The data more or less confirm the adequacy of steel and cast iron for amine absorber and reactivator service. However, they do not take into account the effect of higher temperatures of the walls of heat exchange equipment.

Practical experience has shown that the rate of corrosion depends to a large extent on the reboiler temperature and the skin temperature of the tubes. A number of plants have encountered difficulties with corrosion of steel reboilers and tubes in aqueous-amine systems. Extensive investigations have been made to determine the relative suitability of various metals and alloys for this service in comparison with steel, by installing full size tubes in operating reboilers and by making up small experimental reboiler bundles which were inserted in a slip stream of the plant system.

In one installation using a 30% monoethanolamine solution in water and operating at about 275° F. with steam as the heating medium, the total life of a carbon steel reboiler was approximately 9 months, but tube failures occurred after about 90 days of service. To alleviate the corrosion difficulty, the reboiler temperature was reduced to 250-260° F., but no satisfactory performance of carbon steel equipment could be obtained by this means.

Tests for 70 days with a small reboiler bundle showed that carbon steel and Type 304 stainless steel were severely pitted, while aluminum was in even worse condition. Type 316 stainless was pitted considerably but did not show as bad attack as Type 304. Monel showed only slight etching which substantiated experience with this material in other locations. A subsequent inspection of this bundle after 150 days showed the same results.

In another aqueous-amine plant using a 20% monoethanolamine solution and operating with reboiler temperature of 240° F. and steam as the heating medium, reboiler failures were observed approximately every 12 months. Tests with Monel and Inconel test tubes inserted in a carbon steel bundle indicated the suitability of these materials after 51 weeks operation.

Recent inspection of a Monel reboiler bundle in a refinery after 9 months operation revealed severe corrosion within the carbon steel reactivator tower proper, the unit otherwise being in excellent condition. The tray decks were pitted both top and bottom sides with corrosion occurring entirely throughout the 20 trays. New holddown frogs and clamps were required and, in the top half some new bubble caps. Near the center of the tower the overflow weirs were slightly more corroded and pits in the tower shell were 1/64 in. deep. The tower will be striplined with Monel and the internals eventually replaced with the same material.

The tower operates with a rich aqueous diethanolamine stream entering at 197° F. at the top which has some H_2S and CO_2 and possibly some chlorides (since undesalted Elk Basin crude is

Table 2—Corrosion Tests in Amine Gas Purifying Plants

Test 1—Specimens exposed for 100 days at 180-220° F. near middle of monoethanolamine absorber.

Test 2—Specimens exposed for 270 days at 230° F. on bottom tray of monoethanolamine absorber.

Test 3—Specimens exposed for 483 days at 230° F. opposite diethanolamine reboiler inlet to reactivator.

	Indicated Corrosion Rate In. Penetration/Yr.		
Material	*Test 1*	*Test 2*	*Test 3*
Monel	0.0016	0.0013	0.0021
Nickel	0.0021	0.0033	0.0049
Inconel		0.0001	0.0001
Type 302 & 304	0.0001	0.0001	0.0001**
Type 316		0.0001	
Mild Steel	0.0014*	0.0054	0.0010
Ni-Resist	0.0037	0.0002	0.0011
Cast Iron	0.0082	0.0021	0.017

* Pitted to a max. depth of 0.002 in. during test period.

** Perforated during test period; original thickness of specimens 0.062 in.

charged to make straight-run gasoline vapors, which in turn are DEA treated). The bottom outlet has a reactivated solution leaving at 240° F. The overhead vapor goes out at 220° F. and water refluxes the tower at 150° F. Steam to the reboiler is maintained at about 287° F.

In general it can be concluded that reboiler corrosion is the most severe aspect of the corrosion observed in aqueous-amine plants. The life of carbon steel bundles in some installations has varied from 60 days to more than a year, depending on operating conditions. Reboiler temperature and the presence of oxidation products in the solution appear to be the principal factors affecting the rate of corrosion. Type 304 stainless does not appear to be satisfactory in all instances although good results have been obtained in some cases. Materials most suitable for this service appear to be Monel, Inconel and possibly Type 316 and Carpenter 20.

4—Linde gasoline treater eductors

Problems, Materials: Failure of 4- and 6-in. eductors as follows: Ni-Hard (600 Brinell)—six weeks; 4-6% Cr steel—signs of wear after eight weeks; 4-6% Cr steel lined with cement—signs of wear after eight weeks. Failure or wear occurred in the tailpiece about 1 in. downstream from restriction where velocity was highest.

Process Conditions: Mixture flowing through eductors consists of 80% naptha, 18% 200-mesh clay, 2% cupric chloride and 0.02-0.04% sulfur at 100° F. Linde treater includes a cone-shaped tower with the apex at the bottom. A short vertical pipe connects apex of the cone to a horizontal eductor. Untreated gasoline enters the eductor and contents of the cone tower are drawn into the stream. Pressure upstream from the eductor is 100 psig. and downstream 15 psig. Flow rate is 500 b/hr. for the 6-in. eductor and 110 b/hr. for the 4-in. eductor.

Suggested Solutions: In view of the fact that Ni-Hard with a Brinell hardness of 600 failed in 6 weeks, it is believed that the mixture is acid, highly corrosive and oxidizing in nature. While clay is admittedly an abrasive substance at high velocity, it is inconceivable that it would wear Ni-Hard out in so short a period. It is suspected, therefore, that the failure of Ni-Hard was due to a combination of corrosion as well as some abrasion.

Since the 4-6% chromium alloy is giving better service than Ni-Hard, even though its initial hardness is much lower, it is indicated that corrosion is more of a factor than abrasion. This would seem to be further substantiated by the fact that the acid mixture is causing deterioration of the cement lining in the 4-6% chromium steel eductor.

There is a possibility that Type 316 stainless steel would provide an adequate level of hardness to resist abrasion as well as corrosion, but the first inclination would be to consider the use of some rubber-like material that would have good resistance to the solvent action of the hydrocarbon mixture, such as Neoprene. This type of product would give outstanding abrasion resistance, and if carefully selected for handling the product, it would give long and useful life on that score as well. The temperature of 100° F. involved is well below the upper limit set for the usefulness of such elastomers.

Another suggestion would be to overlay either Stellite or Colmonoy on the 4-6% chrome alloy eductors at the point about 1 in. downstream from the restriction where the velocity is the highest. These hard-facing materials are well known for their high degree of resistance to abrasion and they would be expected to stand up well under the acid oxidizing condition.

5—Gasoline condenser equipment

Problem: Failure of steel mitred elbow sections in six months and 14 in. diameter collecting header in 1½ weeks, handling unstabilized light straight-run gasoline, about ¾ of which is in liquid state and remainder in vapor state.

Materials: Elbow sections and collecting head 4-6% chromium steel.

Process Conditions: Light straight-run gasoline cut, in the form of vapor from the top of the fractionating tower in the crude distilling unit, is partly condensed in heat exchangers, then collected by the elbows and header to be completely condensed and cooled in a cooler box. Rate of flow is 300 b/hr., temperature, 250° F., pressure 30 psig., gasoline sulfur content, 0.02-04%.

Suggested Solutions: The rather premature failure of 4-6% chromium steel in this service is undoubtedly due to small amounts of hydrochloric acid in the gasoline cut. In the event this condition cannot be overcome conveniently by the injection of ammonia for neutralization it will be necessary to go to the use of a more corrosion resistant material.

Data obtained from plant corrosion tests in straight-run gasoline from crude topping towers are believed applicable to the problem application.

It was noted that corrosion of mild steel was the greatest, and the most significant pitting of the austenitic stainless steels occurred under test conditions involving the greatest amount of acidity. The observation that, in one test, the 4-6% chromium steel suffered significant pitting attack in both the liquid and vapor phases confirms practical experience that this class of chromium-containing alloys is prone to this type of attack in acid chloride solutions.

With the exception of the cast materials, Monel was the only one investigated that combined a general low overall corrosion rate with complete freedom from localized attack and it would appear to be the most logical material to consider as a replacement for the 4-6 chromium mitered elbow section and the 14-in. collecting header. The next best materials are 70-30 cupro-nickel and Admiralty Metal, although in two tests each of these showed a tendency toward pitting.

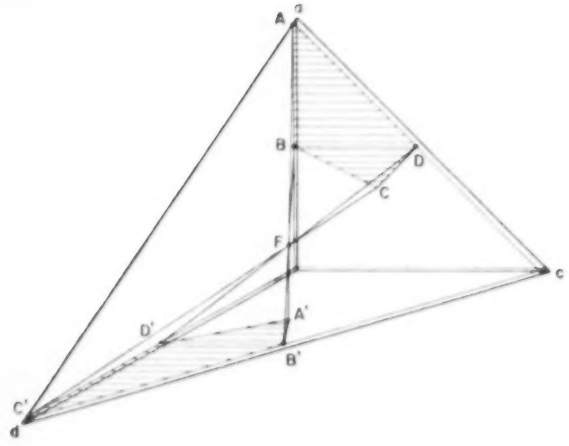


FIG. 1

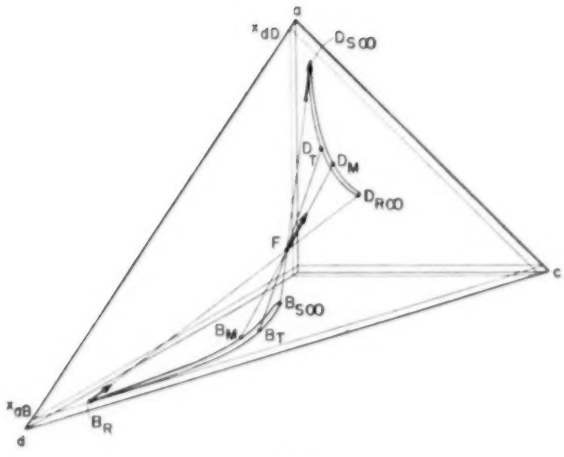


FIG. 2

TO HELP YOU DESIGN FRACTIONATORS

Distillation of Quaternary Mixtures

Complete Columns—Completely Distributed Components

No. 7 in a Series

By ROBERT R. WHITE
Dept. of Chemical and Metallurgical Engrg.
University of Michigan

IN calculating the number of stages required to separate a quaternary feed of known composition and thermal condition into distillate and bottom products, at a fixed pressure, it is necessary to specify only three additional variables in order to "tie-up" all of the other variables, provided that the feed is introduced at the optimum stage (minimum total stage requirement). Thus, if reflux ratio is fixed, there are 16 ways in which to specify a separation by fixing the concentration of one component in the distillate product and the concentration of one component in the bottom product.

The simplest method of specifying the separation will be considered first in applying the principles developed in the preceding articles of this series. This method involves fixing the concentration of the least volatile component of the mixture in the distillate product and the concentration of the most volatile component in the bottom product. This insures that both the distillate and bottom products will contain all of the components which might be said to be "completely distributed" under all conditions. In the following discussions of quaternary distillation "solid" figures are used freely as maps by which calculations may be oriented. In order to clarify the discussion, a specific example will be considered.

Example 1: A saturated liquid feed containing 25.0 mol % each of components *a*, *b*, *c*, and *d*, having relative volatilities of 3.375, 2.25, 1.50 and 1.00 respectively, is to be fractionated to produce a distillate product containing 1.0 mol % of component *d* and a bottom product containing 1.0 mol % of a component *a*.

What is the minimum number of stages that will be required at total reflux and what is the minimum reflux ratio which can be used with an infinite number of stages?

Solution: As a first step, it is of interest to establish the range of composition over which the distillate and bottom product may vary when limited only by a material balance and the specifications of the separation. The locus of all possible distillate products containing 0.01 mol fraction of *d*, which can be produced at the same time a bottom product containing 0.01 mol fraction of *a* is produced from a feed represented by point *F* in Fig. 1 is shown as the shaded area *ABCD*, the corresponding locus of bottom products as the shaded area *A'B'C'D'*. The area *ABCD* may be thought of as that which the area *A'B'C'D'* "sees" through the point *F* as the aperture of a pinhole camera.

A pair of points such as *A* and *A'* may be established through the simultaneous solution of a set of component balances. For example the composition represented by point *A* is

Component	Mol Fraction
a	0.99
b	0.00
c	0.00
d	0.01

so that for 1 mole of feed the component balances are

$$\text{Component } a. \quad 0.25 = 0.99\,D + (1\text{-}D)\,x_{aB} \qquad (1)$$
$$\text{Component } b. \quad 0.25 = 0 + (1\text{-}D)\,x_{bB} \qquad (2)$$
$$\text{Component } c. \quad 0.25 = 0 + (1\text{-}D)\,x_{cB} \qquad (3)$$
$$\text{Component } d. \quad 0.25 = 0.01\,D + (1\text{-}D)\,x_{dB} \qquad (4)$$
$$1.0 = x_{aB} + x_{bB} + x_{cB} + x_{dB} = 1.0 \qquad (5)$$

Equations 1-5 being five independent equations in five unknowns may be solved for any composition x_{iB}.

A simpler and more direct procedure follows from the geometry of Fig. 1. Along the straight line *AFA'*

$$\frac{x_{aD} - x_{aF}}{x_{aF} - x_{aB}} = \frac{x_{iD} - x_{iF}}{x_{iF} - x_{iB}} \quad (6)$$

from which

$$x_{iB} = x_{iF} - (x_{iD} - x_{iF}) \frac{x_{aF} - x_{aB}}{x_{aD} - x_{aF}} \quad (7)$$

Equation 7 permits the calculation of the coordinates of point A' directly.

Similarly in locating points such as B and B', it is known that for B, $x_{cD} = 0.0$ and $x_{dD} = 0.01$, whereas for point B', $x_{aB} = 0.01$ and $x_{bB} = 0.0$. Therefore along the straight line BFB',

$$\frac{x_{aD} - x_{aF}}{x_{aF} - x_{aB}} = \frac{x_{bD} - x_{bF}}{x_{bF} - x_{bB}} \quad (7a)$$

But $x_{aD} = 1 - x_{bD} - x_{cD} - x_{dD} = 0.99 - x_{bD}$ (8)

and therefore

$$x_{bB} = x_{bF} - (x_{bD} - x_{bF}) \frac{x_{aF} - x_{aB}}{x_{aD} - x_{aF}}$$

$$= x_{bF} - (x_{bD} - x_{bF}) \frac{x_{aF} - x_{aB}}{1 - x_{bD} - x_{cD} - x_{dD} - x_{aF}} \quad (9)$$

which permits the direct calculation of x_{bB}.

The various coordinates of Fig. 1 are

Component	A	B	C	D	A'	B'	C'	D'
a	0.99	0.49	0.328	0.49	0.01	0.01	0.01	0.01
b	0.00	0.50	0.331	0.00	0.331	0.00	0.00	0.50
c	0.00	0.00	0.331	0.50	0.331	0.00	0.00	0.00
d	0.01	0.01	0.01	0.01	0.328	0.99	0.99	0.49

Total Reflux Calculations

The calculation of stage requirements and product composition at total reflux involves the trial and error solution of the Fenske-Underwood equation with material balances. The material balances may be reduced to the proportionalities

$$\frac{x_{aD} - x_{aB}}{x_{aF} - x_{aB}} = \frac{x_{bD} - x_{bB}}{x_{bF} - x_{bB}} = \frac{x_{iD} - x_{iB}}{x_{iF} - x_{iB}} = \frac{x_{jD} - x_{jB}}{x_{jF} - x_{jB}} \quad (10)$$

These equations may be rearranged to give

$$\frac{\frac{x_{aD}}{x_{aB}} - 1}{A - 1} = \frac{\frac{x_{bD}}{x_{bB}} - 1}{B - 1} = \frac{\frac{x_{iD}}{x_{iB}} - 1}{I - 1} = \frac{\frac{x_{jD}}{x_{jB}} - 1}{J - 1} \quad (11)$$

where $A = \frac{x_{aF}}{x_{aB}}$, $B = \frac{x_{bF}}{x_{bB}}$, etc.

According to the Fenske-Underwood equation

$$\frac{x_{aD}}{x_{aB}} = \left(\frac{\alpha_a}{\alpha_b}\right)^N \frac{x_{bD}}{x_{bB}}; \quad \frac{x_{aD}}{x_{aB}} = \left(\frac{\alpha_a}{\alpha_j}\right)^N \frac{x_{jD}}{x_{jB}}; \text{ etc.} \quad (12)$$

Substituting Equation 12 in 11

$$\frac{\left(\frac{\alpha_a}{\alpha_j}\right)^N \left(\frac{x_{jD}}{x_{jB}} - 1\right)}{A - 1} = \frac{\left(\frac{\alpha_b}{\alpha_j}\right)^N \left(\frac{x_{jD}}{x_{jB}} - 1\right)}{B - 1} = \frac{\left(\frac{\alpha_i}{\alpha_j}\right)^N \left(\frac{x_{jD}}{x_{jB}} - 1\right)}{I - 1} \quad (13)$$

Solving various pairs of Equations 13 for x_{jD}/x_{jB}

$$x_{jD}/x_{jB} = \frac{\left(A-1\right)\left(\frac{\alpha_b}{\alpha_j}\right)^N - \left(B-1\right)\left(\frac{\alpha_a}{\alpha_j}\right)^N}{A - B} =$$

$$\frac{\left(A-1\right)\left(\frac{\alpha_i}{\alpha_j}\right)^N - \left(I-1\right)\left(\frac{\alpha_a}{\alpha_j}\right)^N}{A - 1} = \text{etc.} \quad (14)$$

from which

$$\left.\begin{aligned} A\ (\alpha_b^N - \alpha_c^N) + B\ (\alpha_c^N - \alpha_a^N) + C\ (\alpha_a^N - \alpha_b^N) &= 0 \\ A\ (\alpha_c^N - \alpha_d^N) + C\ (\alpha_d^N - \alpha_a^N) + D\ (\alpha_a^N - \alpha_c^N) &= 0 \\ B\ (\alpha_c^N - \alpha_d^N) + C\ (\alpha_d^N - \alpha_b^N) + D\ (\alpha_b^N - \alpha_c^N) &= 0 \\ I\ (\alpha_j^N - \alpha_k^N) + J\ (\alpha_k^N - \alpha_i^N) + K\ (\alpha_i^N - \alpha_j^N) &= 0 \end{aligned}\right\} \quad (15)$$

Equations 15 constitute a set of n-2 independent equations which are cyclic in form making them easy to use and remember.

In the example x_{dB} and x_{aB} are known so that the technique of solution is

1—Assume x_{dB}, thereby fixing $D = \frac{x_{dF}}{x_{dB}}$ (10a)

2—Calculate x_{aD} by rearranging Equation 10 to give

$$x_{aD} = x_{aB} + (x_{aF} - x_{aB}) \frac{x_{dD} - x_{dB}}{x_{dF} - x_{dB}}$$

3—Calculate the number of stages N from Equation 12.

4—Calculate the values of $B, C, E, \ldots I, J$ etc., and therefore $x_{bB}, x_{cB}, x_{eB}, \ldots x_{iB}$, etc. from Equations 15 involving A, D, and a third component.

$$A\ (\alpha_d^N - \alpha_i^N) + D\ (\alpha_i^N - \alpha_a^N) + I\ (\alpha_a^N - \alpha_d^N) = 0 \quad (15a)$$

Or where I precedes A in the cyclic order such as when it equals C

$$A\ (\alpha_i^N - \alpha_d^N) + I\ (\alpha_d^N - \alpha_a^N) + D\ (\alpha_a^N - \alpha_i^N) = 0 \quad (15b)$$

5—When the $x_{jB} = 1.0$, the correct assumption in Step 1 has been made.

This procedure is a rapid and sharply convergent trial and error method of evaluating the number of stages as 4.57 and the product composition in the present example as

Component	x_{iD}	x_{iB}
a	0.668	0.010
b	0.260	0.244
c	0.062	0.358
d	0.010	0.388

Finite Reflux Ratios

As with ternary systems, the calculation of stage requirements and product composition as a function of reflux ratio and feed location, involves the assumption of a bottom (or distillate) product composition, and checking the distillate (or bottom) product composition calculated

by a material balance with that produced from stage-to-stage calculations.

Infinite Stages and Minimum Reflux

As with ternary mixtures, for a given separation and reflux ratio, the product compositions and stage requirement depend upon the feed location. The feed may be located so far up the column that an infinite number of stages are required in the stripping section (Fig. 7, Art. 5[D]) or at high values of reflux ratio, the rectifying section may disappear and the separation accomplished in a refluxed stripping column (Figs. 4, 5, 6; Art. 5[D]). At one specific value of reflux ratio, the separation in a refluxed stripping column will require an infinite number of stages at the top of the column. As in the case of the ternary mixtures (Fig. 6, Art. 5[D]) the composition of the products from an infinite stage stripping column may be determined by locating the equilibrium tie line which terminates in the top product specification plane and which extrapolates through the feed point.

For calculating the location of the tie line terminating in the distillate specification plane and extrapolating through the feed point, a derivation similar to Equations 10—15 leads to the cyclic equations

$$A\alpha_a(\alpha_b-\alpha_i)+B\alpha_b(\alpha_i-\alpha_a)+I\alpha_i(\alpha_a-\alpha_b)=0 \quad \ldots\ldots (16)$$

where

$$A=\frac{x_{aF}}{y_{aD}},\ B=\frac{x_{bF}}{y_{bD}},\ I=\frac{x_{aF}}{y_{iD}},\ \text{etc.}$$

The technique of solution is similar to that for the total reflux calculation. In the example y_{aD} is specified. Thus, if y_{bD} is assumed, fixing $B, C, D, \ldots I$ and therefore $y_{cD}, y_{dD}, \ldots$ may be calculated from Equation 16. When $y_{iD}=1.0$, the assumption of y_{bD} is correct. This leads to the following results which are plotted in Fig. 2 as D_{Rx} and B_{Rx}.

Component	Distillate Product, y_D	Bottom Product, x_B	Liquid in Equilibrium with Overhead Vapor (y_D)
a	0.9254	0.0100	0.8645
b	0.0457	0.3225	0.0641
c	0.0189	0.3318	0.0397
d	0.0100	0.3350	0.0317

As with ternary systems

$$\frac{L}{D}=\left(\frac{F}{D}\right)\left(\frac{L}{F}\right)=\left(\frac{B_{Sc}D_{Sc}}{B_{Sc}F}\right)\left(\frac{FL}{LD}\right)=$$

$$\left(\frac{0.9254-0.0100}{0.250-0.0100}\right)\left(\frac{0.8654-0.250}{0.9254-0.8645}\right)=38.5$$

and

$$\frac{L}{V}=\frac{38.5}{38.5+1}=0.975$$

Similarly, the feed may be located so far down the column that an infinite number of stages are required in the rectifying section, or at high values of reflux ratio, the stripping section may disappear and the separation accomplished in a reboiled rectifying column (Fig. 8, Art. 5[D]). At one specific value of reflux ratio, the separation in a reboiled rectifying column will require an infinite number of stages at the bottom of the column. (Fig. 10, Art. 5[D])

As with ternary systems, the composition of the products from an infinite stage rectifying column may be determined by locating the equilibrium tie line originating in the bottom product specification plane which extrapolates through the feed point. This may be calculated from the cyclic equation

$$A(\alpha_b-\alpha_i)+B(\alpha_i-\alpha_a)+I(\alpha_a-\alpha_b)=0 \quad \ldots\ldots (17)$$

where

$$A=\frac{x_{aF}}{x_{aB}},\ B=\frac{x_{bF}}{x_{bB}},\ I=\frac{x_{iF}}{x_{iB}},\ \text{etc.}$$

The result in the current example is shown in Fig. 2 as D_{Rx} and B_{Rx} is

Component	Bottom Product Mol Fraction x_B	Vapor in Equil. with Bottom Product	Distillate Product y_D
a	0.0100	0.0315	0.335
b	0.0189	0.0397	0.332
c	0.0457	0.0641	0.323
d	0.9254	0.8647	0.010
	1.0000	1.0000	1.000

As shown in Fig. 2, since the liquid in the zone of infinite stages has the same composition as the bottom product,

$$\frac{L}{V}=\frac{DV}{DB}=\frac{0.8547}{0.9154}=0.935,\quad \frac{L}{D}=\frac{DV}{BV}=\frac{0.8547}{0.0606}=14.1.$$

At total reflux, the location of the feed stage is immaterial since the capacity of the column is zero. As with ternary distillation, as the reflux ratio decreases from infinity, there is a range of products meeting the specifications depending upon the location of the feed stage, the optimum feed location giving the minimum number of stages. The range of variation of the product composition eventually becomes zero at the minimum reflux ratio and, with the feed stage located in its optimum point of the column, the points representing the distillate and bottom products of the column tend to align themselves with the equilibrium tie line through the feed point. Thus, at the minimum reflux, with the separation specified by x_{aB} and x_{dD}, the zone of infinite stages develops at the feed stage analogous to the behavior shown in Fig. 11, Art. 5[D] for ternary systems. The composition of the distillate and bottom products are represented by the points of intersection of the tie line originating at the feed point and the planes representing the separation specifications. The composition of the bottom product as calculated by what should now be familiar methods are

Component	Bottom Product Composition Mol Fraction at Minimum Reflux	Vapor in Equil. with Feed Mol Fraction	Distillate Product Composition Minimum Reflux Mol Fraction
a	0.0100	0.4154	0.561
b	0.2107	0.2769	0.301
c	0.3443	0.1846	0.128
d	0.4350	0.1231	0.010
	1.0000	1.0000	1.000

From Figure 2 the value $\frac{L}{D}=\frac{D_M V_F}{F V_F}=\frac{0.123-0.010}{0.250-0.123}=0.89$

and $L/V=0.471$

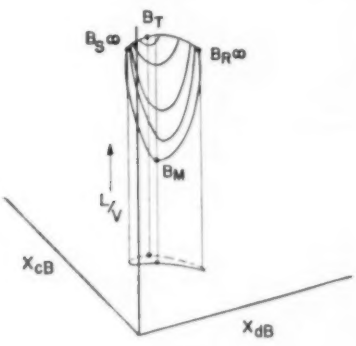


FIG. 3

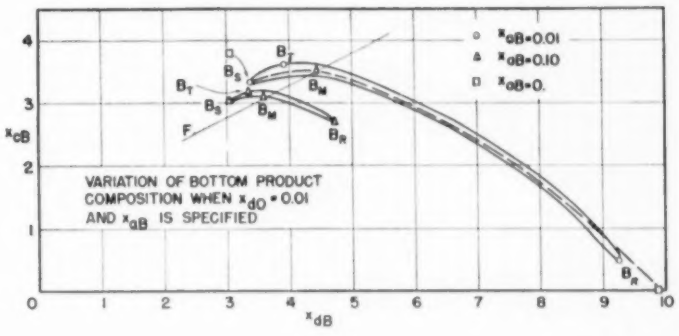


FIG. 4

The compositions of the bottom product for the various design conditions are presented in Table 1 along with similar values for a separation specified by $x_{aB} = 0.10$ and $x_{dD} = 0.10$ in order to show the effect of various specifications.

The relationship between the bottom product compositions, the value of L/V, and the number of stages for the separation specified by x_{aB} and $x_{dD} = 0.01$ is shown in the three dimensional diagram of Fig. 3. The contour lines on this surface represent a constant number of stages. This figure is analogous to Fig 12, Art. 5[1] for ternary systems and has basically the same characteristics except that instead of having a plane surface as for ternary mixtures, Fig. 3 represents a surface curved in space. The projection of the curved surface on a plane is shown at the base of the diagram.

The projection of the surface of Fig. 3 and similar projections for the separation specified by $x_{aB} = 0.01$ and $x_{dD} = 0.01$ are shown on Fig. 4 which illustrates a number of interesting features. The effect of increasing the difficulty of separation by reducing the amount of component a in the bottom product is to extend the range of product composition. The elongated slender shape of the projected surface is characteristic. If the specification of component a in the bottom product were 0.25, the area would reduce to the point F representing the feed since the tie line originating in the bottom product specification and which passes through the feed point would be coincident with the feed tie line. Thus, the point B_S becomes identical to the point B_M. Similar considerations move the point B_T and B_R to the point F. Since the locus of the points B_M results from the extrapolation of a straight line, the locus becomes a straight line in Fig. 4 as shown. When the amount of component a in the bottom product becomes zero, the point B_{Rz} moves to $x_d = 0.99$, the point B_{Sz} is still located by the extrapolation of the tie line terminating in $y_d = 0.01$ and the calculation of the bottom product at total reflux becomes indeterminate by the methods described. Actually, it becomes impossible to produce a perfect separation of component a in a reboiled rectifying column except at total reflux and infinite stages, so that the point B_t becomes coincident with the point B_{Rz} the slope of the surface of Fig. 3 becoming infinity (walls become vertical) and the projection of the surface becoming a curve as shown in Fig. 4.

Again, Figs. 3 and 4 show that it is imperative that the term minimum reflux be closely identified with the separation specifications. When x_{aB} and x_{dD} are specified, the minimum reflux is that indicated by a point such as B_M. However, if, as is sometimes done, x_{aB} x_{dB} and x_{dD} are specified, the minimum reflux becomes defined by a point on the curve representing infinite stages, not necessarily B_M, and feed location ceases to be a variable in the calculation of the relationship between reflux ratio and the number of stages required as evidenced by an intersection of a plane of constant x_d with the surface of Fig. 3.

References

(1) White, R. R., PETROLEUM PROCESSING, 8, 892 (1953).

Table 1—Product Compositions

Feed: 0.250 mol fraction of a, b, c, and d

	Total Reflux mol fraction		*Minimum Reflux mol fraction*		*Refluxed Stripping Column Infinite Stages mol fraction*		*Reboiled Rectifying Column Infinite Stages mol fraction*	
	x_B	x_D	x_B	x_D	x_B	x_D	x_B	x_D
Separation specified by $X_{aB} = 0.01$, $X_{dD} = 0.01$								
L/V			0.471		0.975		0.935	
a	0.010	0.668	.0100	0.561	0.0100	0.9254	0.0100	0.335
b	0.244	0.260	0.211	0.301	0.325	0.0457	0.0189	0.332
c	0.358	0.062	0.344	0.128	0.332	0.0189	0.0457	0.323
d	0.388	0.010	0.4350	0.010	0.3350	0.0100	0.9254	.010
$n = 4.57$								
Separation specified by $X_{aB} = 0.10$, $X_{dD} = 0.01$								
L/V			0.473		0.985		0.652	
a	0.100	0.664	0.100	0.563	0.1000	0.929	0.1000	0.415
b	0.245	0.264	0.226	0.300	0.296	0.042	0.160	0.348
c	0.318	0.062	0.309	0.127	0.301	0.019	0.269	0.229
d	0.337	0.010	0.365	0.010	0.303	0.010	0.471	0.010
$n = 4.46$								
Separation specified by $X_{aB} = 0.0$, $X_{dD} = 0.01$								
a	0.000	0.330	0.000	0.563	0.000	0.931	0.000	0.330
b	0.000	0.330	0.209	0.301	0.326	0.043	0.000	0.330
c	0.000	0.330	0.349	0.126	0.336	0.016	0.000	0.330
d	1.000	0.010	0.442	0.010	0.338	0.010	1.000	0.010

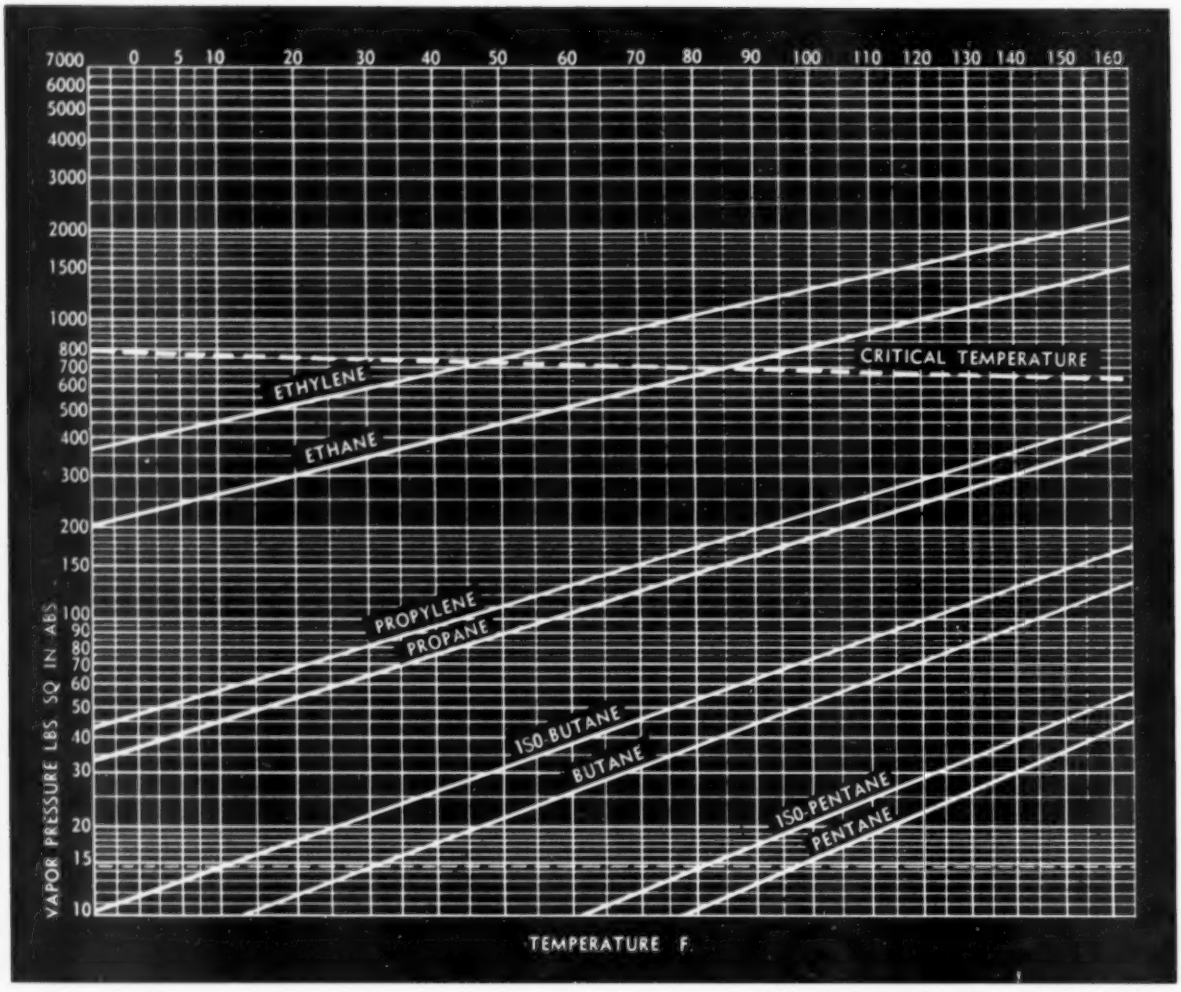


Chart courtesy Natural Gasoline Supply Mens Association

FIG. 1—Temperature vs. vapor pressure for some light hydrocarbons

Tips on Sealing Light Hydrocarbons

By RALPH E. MORGAN
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IN the sealing of pumps which handle light hydrocarbons with very high vapor pressures—such as liquefied petroleum gases—some applications will occasionally present a great deal of difficulty. However, a few facts have been established through study of these problems that should be of help to users of mechanical seals.

For example, the pressure in the stuffing box must be higher by a comparatively safe margin than the vapor pressure of the material being pumped. A very important factor related to vapor pressure is the temperature, because a temperature rise brings about an immediate rise in vapor pressure. Therefore, if the fluid pressure on the seal is only slightly above the vapor pressure of that fluid, the film of liquid between the seal faces may suddenly expand into a gas because of only the small amount of friction heat of the rubbing faces.

This sudden expansion will cause the seal faces to pop open. If the expansion is not too severe, the faces may close again. When the expansion and opening is severe enough to cause refrigeration, then ice formations will prevent the seal faces from closing.

What are the effects of temperature and vapor pressure of some light hydrocarbons on a mechanical seal? The results of some tests run on propane are shown in Table 1. The tests were run at three different pressures—300, 400, and 600 psi. The temperature in the system was varied from 60 to 140° F. Readings were taken by thermocouples in the stuffing box and in the carbon insert in the seal. The latter thermocouple was located approximately 1/16 in. from the seal faces. The seal used in the test is shown in the photograph. It is designed for recommended temperature of —40 to 250° F., pressures of 50 to 600 psi., and for any fluids that will not attack "O" ring compounds like neoprene,

Buna-N and Silicone rubber.

The data in Table 1 also shows the vapor pressure for propane for each of the temperatures recorded. It will be noted that the seal faces opened or popped only when the vapor pressure approached the system pressure. This was during the 300 psi. test when the temperature was 140° F., and the corresponding vapor pressure was 291 psi. The popping was easily stopped by raising the system pressure or by cooling the propane.

The chart in Fig. 1 shows the vapor pressure-vs.-temperature curves for a number of hydrocarbons up to 160° F. The curve for propane indicates that a temperature rise from 100 to 110° F. involves a vapor pressure rise from 187 to about 220 psi. In other words, in this range vapor pressure rises approximately 3 psi./° F.

Examination of the curve for ethane shows it crossing the critical temperature line at 90° F. and the curve for ethylene crossing the same line at 50° F. It should be explained that the critical temperature is that temperature above which no amount of increased pressure will cause liquefying.

It should therefore be assumed that for any hydrocarbons containing ethane above 90° F. or ethylene above 50° F., seal trouble can be expected. There is, of course, a certain amount of temperature rise (though very small) on the seal faces. Therefore, the process fluid temperature has to be kept safely below the temperature necessary for keeping the fluid in a liquid state.

What temperature is safe? For propane, the recommendation is a temperature which will keep the vapor pressure 25 to 50 psi. below the stuffing-box temperature. For ethane and ethylene a greater differential may be necessary.

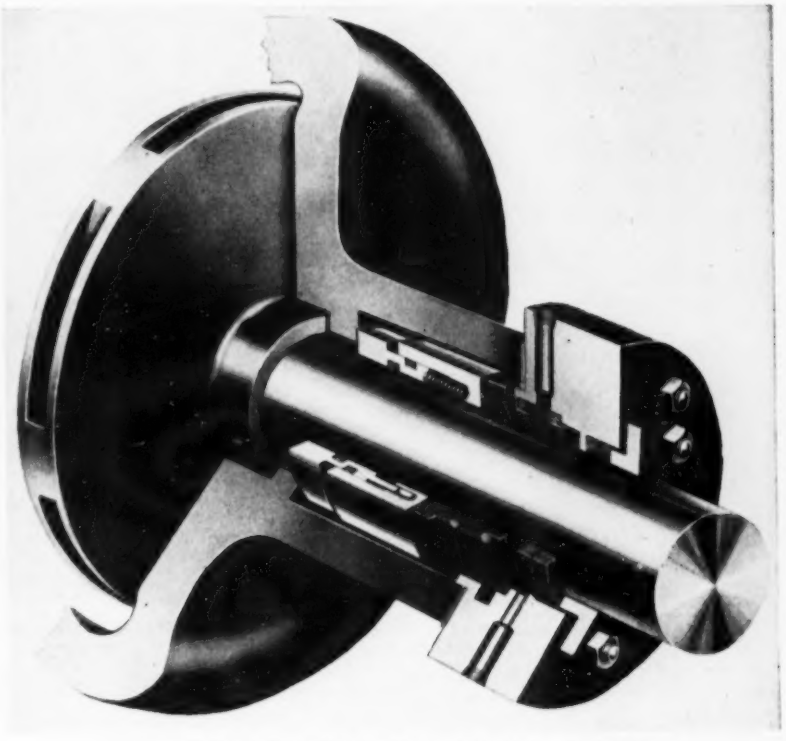
In cases where the temperatures are not close to the critical temperature, an increased stuffing-box pressure will give a greater differential over the vapor pressure.

In one refinery, for example, where a number of mechanical seals of the type used in the above test were installed and giving good service; a few changes in the refinery process were made and the seals began popping. The pump was equipped with a bypass line from the pump discharge to the stuffing box. However, the bypass line contained a small orifice which did not permit a pressure build-up in the stuffing box.

The orifice was removed and replaced with a valve which was regulated to build up the pressure around the seal. The units immediately quit popping and began running smoothly.

There is another fact which must not be forgotten when mechanical seals are installed in pumps handling light hydrocarbons. Invariably, such pumps are tested first with water before being put into hydrocarbon service. It is believed that it is impossible to get all of this water out of the pump stuffing box. Naturally, the water will freeze if the pump temperature drops below 32° F., or if there is some refrigeration caused by the hydrocarbon expanding should the seal pop open.

A solution to this problem, as developed by one user, was to change to a lubricated mechanical seal and then use methyl alcohol as the lubricant to prevent the freezing and icing. This lubrication was discontinued after it was apparent that all the water was out of the system.



MECHANICAL SEAL of the type used in the test program

Table 1—Effects of Temperature and Vapor Pressure on a Mechanical Seal Handling Propane

System Pressure psig	Temperature			Vapor Pressure		
	System °F.	St. Box °F.	Faces °F.	System psig.	St. Box psig.	Faces psig.
300	60	60	60	93	93	93
300	80	80	80	128	128	128
300	100	100	100	172	172	172
300	120	120	120	225	225	225
300	130	130	130	257	257	257
300	140	140	140	291	291	291*
400	60	60	65	93	93	101
400	80	80	80	128	128	128
400	100	100	100	172	172	172
400	120	120	120	225	225	225
400	140	140	140	291	291	291
600	120	120	125	225	225	239
600	140	140	145	291	291	305

* No evidence of vapor leaks except at this condition during entire test. Here, vapor pressure approached system pressure. Seal leaked, excessive vapor blow, and popping.

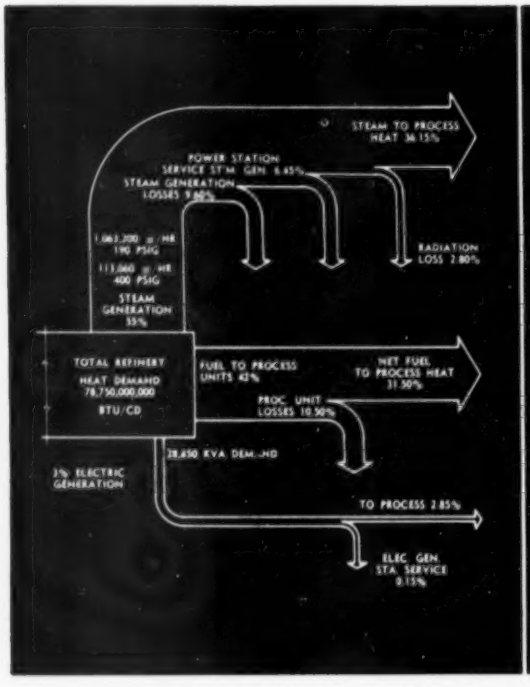


FIG. 1—WINTER HEAT BALANCE of a typical refinery in Middle Atlantic States

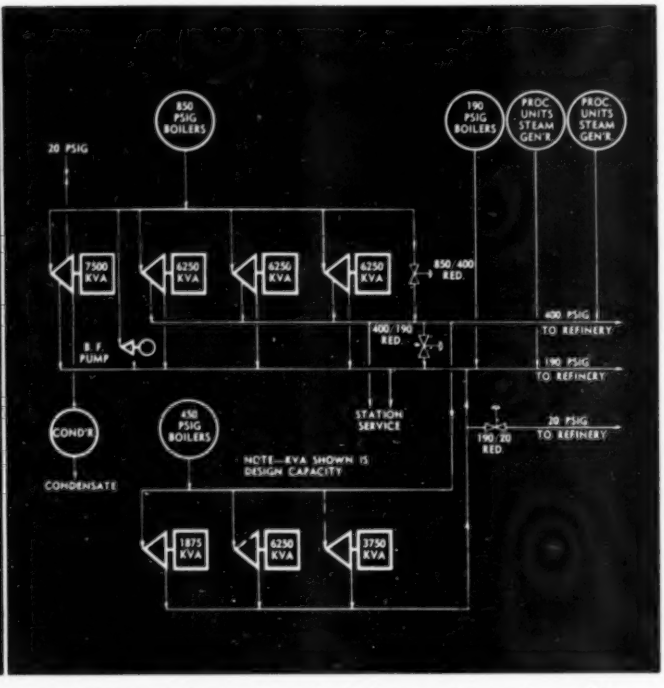


FIG. 2—STEAM SYSTEM of a typical refinery, using topping turbines as motive power for electric generation

FACTORS IN THE DESIGN OF *Electrical Distribution Systems*

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IN addition to any special, local processing conditions, attention should be given to the following five factors in the design of refinery electrical distribution systems.

1—The heat balance. What equipment should be driven electrically so as to maintain the balance, and how much electricity is available for distribution?

2—The analysis of the electrical load. What is the present load? How much spare generating capacity exists? What spare capacity remains in the distribution system? And what is the ultimate demand?

3—Electrical demand estimates for the new process unit. This should be done using a "three-estimate" method, comprising: a) the demand as estimated from the flow diagram; b) the maximum demand as determined from the single line diagram, with forecasts from the process department; and c) the ultimate demand when equipment design is firm, such as from pump characteristic curves.

4—Effect of impeller size on estimate of ultimate demand. Will the new distribution system be adequate to accept the demand of larger motors to drive larger impellers?

5—The two-voltage system. Are loads and transmission factors sufficient to justify one? Can the new distribution system be developed into a two-voltage system? Or can it be designed for future transition?

These factors are not all-inclusive, but they are important in refinery electrical engineering. In addition, the last design considerations should always be directed to safety, accessibility, and ease of maintenance.

One essential design characteristic must always be present in all planning—the distribution system must meet refinery conditions. Whether power is supplied by the company's own central power station, a public utility firm, or a combination of the two; that electricity has to be distributed. Therefore, a plan for such distribution must be established and agreed upon—a plan which perhaps may be developed as a radial system, a loop system, or a combination of both.

Although construction of an entirely new refinery today is relatively infrequent, additions and changes are usual. Accordingly, this paper applies largely to expanding existing distribution facilities to meet the burdens of processing changes and additions in an established refinery.

The process engineer is the starting point for problems of electrical distribution. He develops the production pattern for future needs — what

changes shall be made process-wise, and what processing facilities will be required. The electrical engineer, on the other hand, has the job of designing, selecting, and procuring electrical equipment components embodied in the distribution system. It is his responsibility to insure that proper equipment is specified.

Special Refinery Conditions

Conditions exist in refineries which are unlike those in most other industries. These, of course, influence distribution system design. Some of those applying to the refinery as a whole are:

1—Size: Refineries cover relatively large land areas, ranging from several hundred to more than a thousand acres.

2—Steam and electric power: Refineries use vast quantities of steam and substantial quantities of electric power 24 hrs. a day, month after month. Northern refineries have the additional factor of being subject to seasonal variations.

3—Production hazards: Refinery installations must be made to meet the potential hazards which accompany the handling of flammable and explosive vapors.

Certain conditions will apply to parts or units of the refinery:

1—Continuous operation: Process units operate around the clock, rarely coming off stream except for annual overhauls or for occasional emergencies.

2—Limited adaptability to change: Most process units are adaptable to limited change in design, but eventually suffer total obsolescence, at which time the whole unit is often dismantled. Frequently, the existing site may not even be adequate for a replacement unit.

3—Large and more complex units: In keeping pace with product demand, process units are tending to become larger and more complex. New construction is often more distant from the center of distribution.

Heat for petroleum processing, other than that obtained from fuel delivered direct to process furnaces, is almost universally produced by steam generating plants within the refinery. Frequent practice is to use this steam source in turn for electrical generation.

Cost of electricity is comparatively low, if it is generated by turbo-generators, designed for steam pressures sufficiently high to utilize the exhaust for refinery heating and mechanical processes. To maximize the use of existing steam and electrical facilities, to have the lowest capital outlay, and to otherwise serve its intended purpose; existing and proposed conditions must be carefully analyzed. Studies should be made of the heat balance, existing electrical demand, projected electrical demand for the new facilities, and possible incorporation of existing and proposed distribution into a two-voltage system, if none existed before.

Table 1—Typical Electric and Steam Demands for Various Types of Process Units

Unit	*KWH/Bbl.*	*Lbs. Steam/Bbl.*
Two-stage distillation	0.60	20.9
Catalytic cracking	1.20	25.0
Thermal cracking (with gas plt.)	0.56	——*
H. F. alkylation	5.80	699.0
Propane deasphalting	1.05	136.0
Thermal reforming	0.52	——*
Solvent dewaxing	2.80	337.0
Furfural solvent refining	0.70	38.0

* Generates steam.

Heat Balance

The major factor governing the amount of electricity to be distributed is the maintenance of a proper ratio between electricity and steam demand that will effect a refinery heat balance. Otherwise, boiler equipment may produce more high level steam than can be consumed readily in processing operations and directly affect the amount of steam available for electric generation. Fig. 1 shows a winter heat balance for a typical Middle Atlantic States refinery in which the demand is 28,850 KVA. Fig. 2 shows the steam system for the same plant, including the utilization of topping turbines as motive power for electrical generation. The total generating design capacity of 38,125 KVA provides both the capacity for meeting the demand shown in Fig. 1 as well as that for generator outages for maintenance purposes.

Depending upon the heat level required for processing, refineries using widely divergent processing schemes will have varying relations between steam and electric demand. For example, a plant with a substantial lube oil processing activity may differ in this relationship from one devoted largely to cracking.

Ideally, and in any type of refinery, the steam consumers should be so arranged that the exhaust of high pressure-high temperature users becomes the supply for the next user, and so on, until after the last low pressure-low temperature user, only condensate remains. Insured quality condensate is reusable. It follows then, that for economy in the steam system, the design of the electrical distribution system should embody provisions for distributing potential electric generating capacity made available by the steam system.

Electrical Demand—Present and Future

Load analysis is a never-ending problem inasmuch as the petroleum processing industry is constantly growing. Improved old and new processes create additional demands or eliminate old ones. Thus load statements should be prepared on a regular and continuing basis.

To estimate the demand of a system, data can be obtained from ammeter and watt-hour meters if they are installed on feeders at central stations, at load centers; and from ammeters if installed on the transformer banks. These data are then available from central station log sheets on which the operator has logged daily the feeder ammeter readings, and from periodic field records of ammeter readings of each transformer bank.

When the daily "highs" of feeder readings are plotted with the demand of the transformers connected to the feeder, the resulting graph will indicate the capacity of existing equipment to supply additional load.

A realistic estimate of new facilities' requirements can be made, if the monthly average of feeder ammeter and watt-hour meter readings is plotted with the monthly thru-put of the facilities served by the feeder. This plot can also be used to determine the diversity factor of the refinery, which will assist in the planning of the overall capacity of the generating station. The watt-hour meter readings also may be used for economic studies.

Unless the ultimate thru-put capacity is established, and the design of the utilities system is correlated with

the ultimate demand for such capacity, the problems and expense entailed in expanding the refinery increase beyond reasonable expectations. If the ultimate capacity of a central station has not been established for the ultimate refinery demand, anticipated load increases must be foreseen and planned for long in advance of committed loads. Process and engineering departments must develop jointly the future picture.

Reliable guides exist to govern the thinking into the future. They are: a) available real estate for future plot sites, b) available existing utility capacity for process units, without requiring a major expansion of steam and electric generating facilities, and c) the age of existing process units.

In applying these guides, consideration must be given to the fact that larger capacity units of high efficiency may have power requirements of different relation to thru-put than the older, smaller, and less efficient units. Table 1 shows average electric and steam demands on a per bbl. thru-put basis for several types of process units. The values shown do not include any provisions for non-thru-put facilities such as may be needed for maintenance shops, offices, packaging, lighting, water supply, and specialties.

Estimating Demand—New Process Units

It is usually necessary to determine an approximate demand well in advance of the time when final mechanical data are available, when demand estimates are required for new process units to be constructed. This is so that central station expansion, should it be necessary, can be anticipated and orders placed for generators, etc.

Three demand estimates are therefore recommended: the first—when a flow diagram becomes available, the second—a recheck when the single line diagram and name plate data become available, and the third—when pump characteristic curves are available.

On the initial estimate, utility and project engineers should estimate roughly the horsepower requirements and decide which pumps are to be steam or electric driven, using the flow diagram. If the motor requirements of each pump are approximated, a rough estimate of total power demand can be made by assuming one motor hp. equal to one KVA.

This motorpower demand, plus 15% to allow for lighting and changes as the design progresses, will result in a figure sufficiently accurate for estimating the additional demand on the central station. It will also be a sufficiently accurate figure for estimating costs of transformers and cables.

Once the proposed single line diagram is available, a recheck of the original demand should be made. This should use the nameplate hp. of motors operated at less than 2400 volts as equal to one KVA and the manufacturer's guaranteed KVA values for primary voltage motors. To the algebraic sum of this power demand should be added the KVA rating of the lighting transformer. Then another 5% should be added to this total for contingencies.

At this point, discussion should be held with the process department as to the possibility of increasing thru-put above rated design capacity. If this is a possibility with minor changes; to estimate the maximum demand, the calculated KVA demand should be prorated on a KVA/bbl. basis and then multiplied by the maximum bbl. thru-put. The 5% factor for contingencies is not used in making this estimate.

The figure so obtained is sufficiently accurate for determining transformer-motor groupings. It is also sufficiently accurate for making cable and transformer economy studies.

If this step were not taken, a process unit might be developed that would be limited by the electrical system, making the cost of incremental bbl. of thru-put capacity unattractive.

When the design progresses to the point where pump sizes and lighting requirements are firm, the horsepower out-put should be determined for each motor by using the pump characteristic curves. Then, with the manufacturer's guaranteed values of efficiency and power factor, the active and reactive components for each motor should be determined. The design demand is determined by adding all active and reactive components of the power and lighting system algebraically and by combining these totals vectorially.

Effect of Impeller Size

To determine the effect of pump impeller size, it should be noted whether or not a proper motor has been specified for use with the pump. There are times when a motor is sized for the design impeller, with the idea of later increasing the motor size if a larger impeller is installed.

This approach, while perhaps justifiable for first cost economy on motors and pumping equipment, may not always be sound for the design of the distribution system. A larger motor may require a larger starter and perhaps some changes in conduit. This possibility is a proper subject for the electrical engineer to discuss with project and process engineers. If the ultimate design is based in changing impellers at some future date, the pump curves for maximum impeller design must be used with the estimated additional equipment requirements in making a more realistic determination of the ultimate demand. The distribution system should be designed to meet this latter figure.

Two-Voltage System

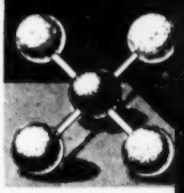
Consideration should be given to a two-voltage system when planning takes place, either for expansion of existing facilities or for a new station, providing the loads and transmission factors warrant it. Such a system would consist of:

1—A 2.4 KV bus system, with reactors to limit the refinery equipment to the planned interrupting capacity, for serving a normal refinery demand to a total of approximately 10,000 KVA distributed over relatively short transmission lines and to permit direct connection of 2300 volt motors to the primary system.

2—A 13.2 KV bus system, connected to the 2.4 KV bus with a transformer to allow the transfer of power between busses during generator outages, for serving loads in excess of the 10,000 KVA. The impedance of this transformer may be used to limit the fault current to an interrupting value within the range of the 2.4 KV central station breakers. Loads in remote areas would be supplied by load centers connected to the 13.2 KV bus. The building of load centers supplied from the 13.2 KV bus and the installation of dual feeders through different duct systems would permit the system to be expanded to satisfy the requirements of a refinery area. Each load center would be equipped with 13.2/2.4 KV transformers and 2.4 KV breakers having a 100,000 KVA interrupting capacity. This is based on using a radial distribution system with single feeders for the 2.4 KV system.

The preceding article consists of a paper, "Design Factors of Refinery Electrical Distribution," from the American Institute of Electrical Engineers' meeting, June 15-19, Atlantic City, and made available to PETROLEUM PROCESSING by the authors.

W. A. Sibson is supervisor of utilities engineering; H. G. Buch is refinery electrical engineer; and J. F. Eisenhardt is asst. refinery electrical engineer; Socony-Vacuum Oil Co., Inc., at the Paulsboro, N.J., refinery.



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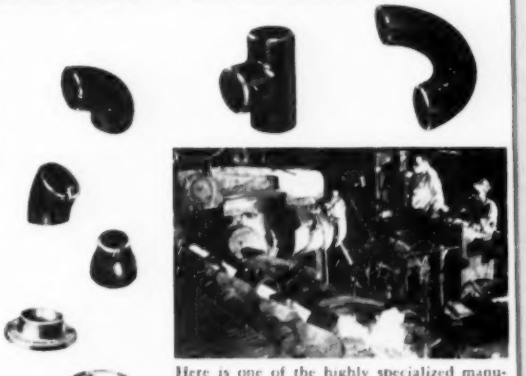

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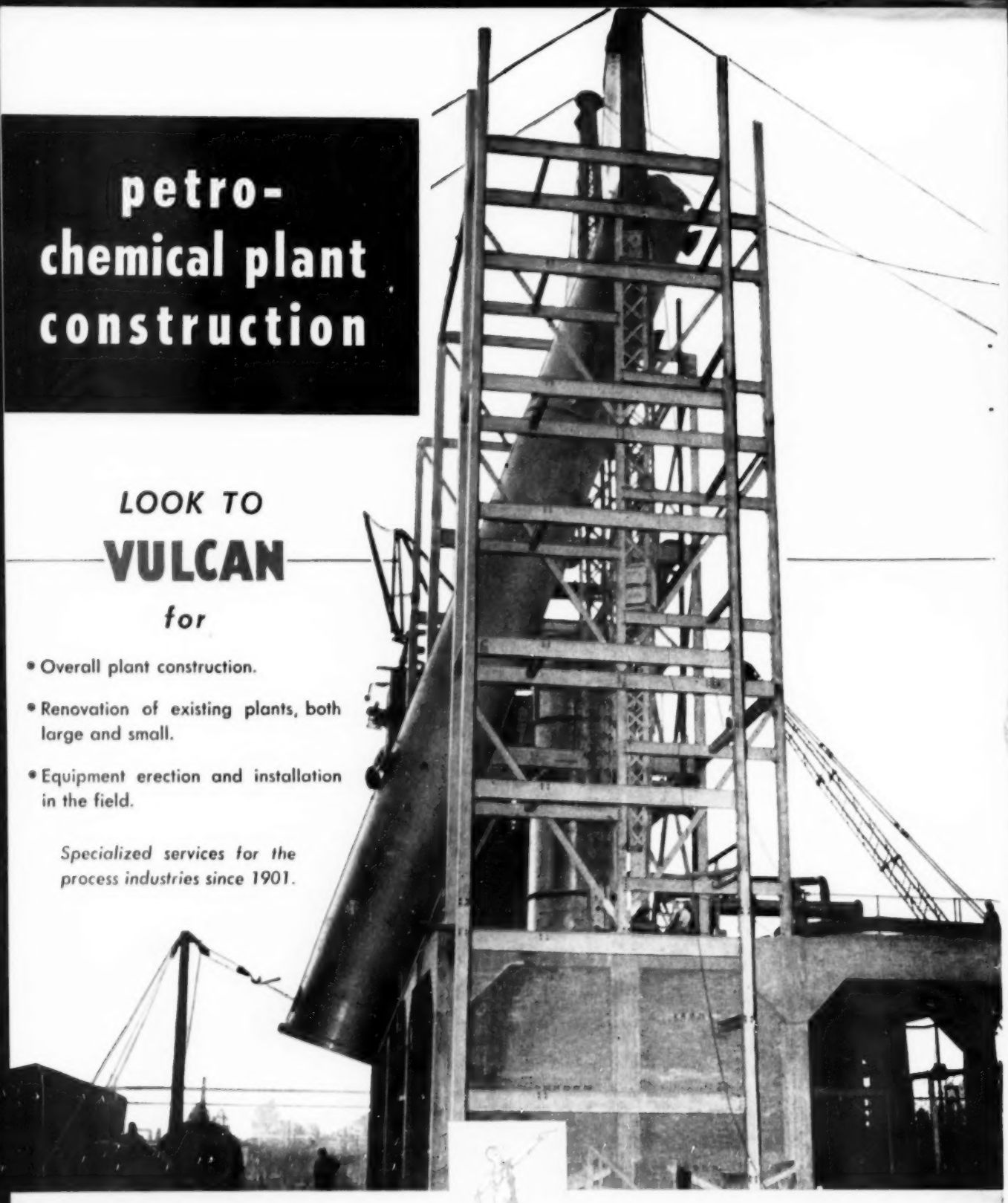

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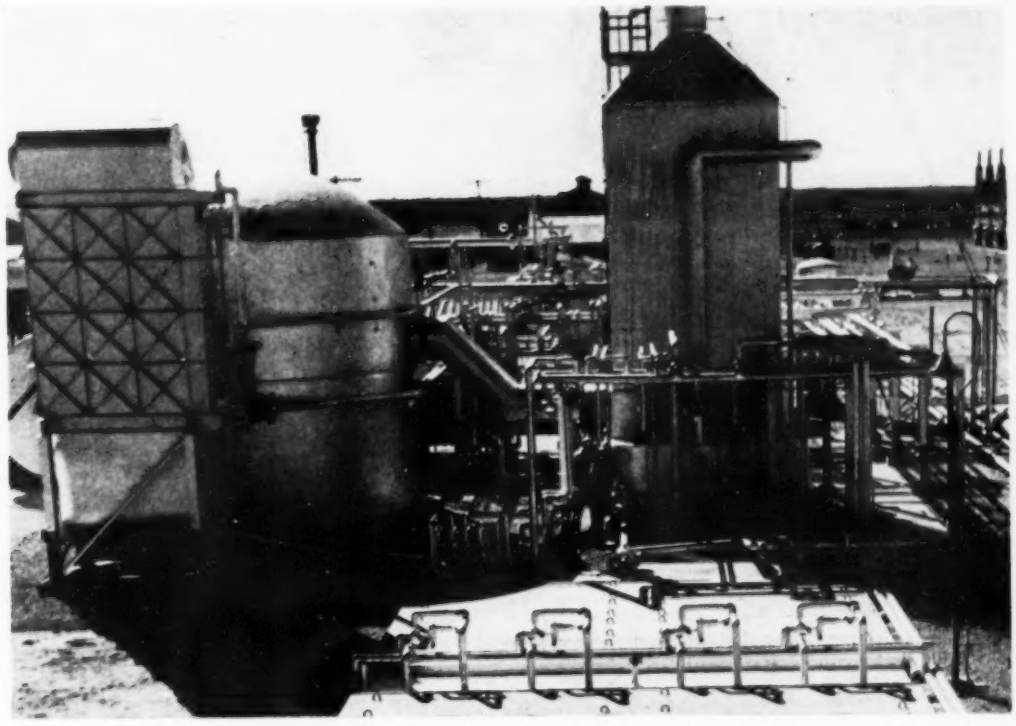


COMPACTNESS IS FEATURE of recovery plant. Sulfur sump in foreground, wash tower immediately behind, catalytic converter at left

H_2S Low but Sulfur Recovery High

New 61 ton/day plant uses acid feed gas with only 15% hydrogen sulfide content

By JAMES F. MULLOWNEY
The Fluor Corp. Ltd.

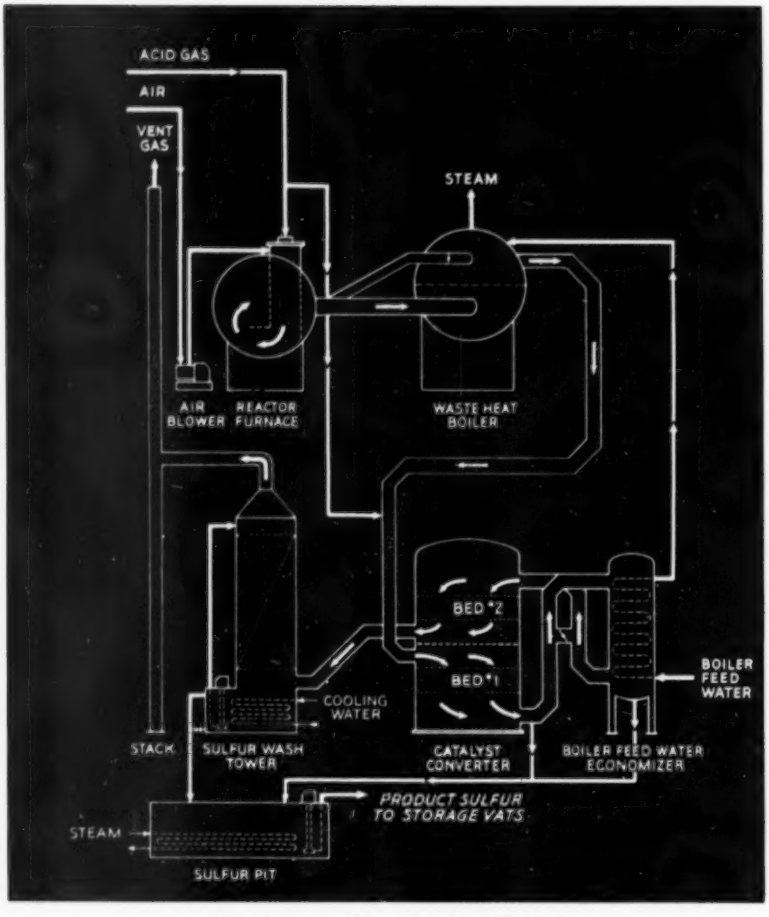
USING acid feed gas of very low hydrogen sulfide content — 15.5 mol-% — a 61 short ton/day sulfur recovery unit has been placed on stream recently by Stanolind Oil and Gas Co. at the Slaughter Field natural gas—gasoline plant near Sundown, Texas, which it operates for a group of co-owners.

The sulfur plant, designed and constructed by The Fluor Corp. Ltd., operates in conjunction with a gas sweetening unit which removes the acidic contaminants (H_2S and CO_2) from natural gas. The gas treating unit uses an aqueous monoethanolamine solution as an absorption medium, removing approximately 8,000,000 SCF/D acid gases, which constitute the sulfur unit's feed stock.

Average composition of this feed gas, supplied to the unit at 5 psig. and 80° F. is approximately: H_2S, 15.5 mol-%; Hydrocarbon, 2.5 mol-%; H_2O, 2.1 mol-%; and CO_2, 79.9 mol-%.

During a recent 48-hr. performance test, the sulfur unit recovered 92% of the sulfur available in the acid gas feed. Approximately 88% of this amount was catalytically converted in the primary catalyst bed. Sulfur produced from H_2S-bearing gases by this process is extremely pure. Analysis of sulfur from the plant indicates a purity of better than 99.94% with no more than 0.005 wt.-% ash. This product is therefore an excellent raw material for chemical manufacturing and is ideal for sulfuric acid manufacture.

Even though the quantity of combustibles present in the acid gas feed is very low, no difficulties are encountered in maintaining proper combustion conditions in the specially-designed reactor furnace. The furnace is so designed that the inlet acid gas and air are indirectly preheated by the products of combustion. Combustion of the gases takes place in a region of loosely packed high temperature firebrick in the form of a checker wall. Through the use of recuperative heating and extended combustion surface, the possibility of the flame becoming extinguished is prevented. The internal firebrick retains its incandescence for an appreciable time; therefore, it is not neces-



FLOW DIAGRAM of the Slaughter Field plant.

sary to have an ignition system in the furnace to relight the acid gas should its flow be stopped momentarily. It is also possible to start the furnace up without preheating after a short shutdown.

Preheating of the furnace is accomplished by burning natural gas in special auxiliary burners installed in ports especially made for this purpose. When furnace effluent temperature has reached a predetermined point, the auxiliary burners are removed and the ports bricked up. The feed gas and air are then admitted and preheating of the rest of the plant is continued, using SO_2 to bring the catalyst beds and other equipment to operating temperature.

A simplified flow scheme of the process is shown in the drawing. This sulfur plant was designed for split flow operation in that one-third of the acid gas is fed to the reactor furnace with the stoichiometric quantity of air required to obtain complete combustion of the H_2S to SO_2 and water, and of the hydrocarbons to CO_2 and water. Principal reactions in the furnace are:

$$H_2S + 3/2\ O_2 \longrightarrow SO_2 + H_2O$$
$$CH_4 + 2\ O_2 \longrightarrow CO_2 + 2H_2O$$

The remaining acid gases which bypass the reactor furnace and waste-heat boiler combine with the furnace effluent and flow into the primary catalyst bed, where the following reaction takes place:

$$2H_2S + SO_2 \longrightarrow 3S + 2H_2O$$

The hydrocarbons contained in the bypassed acid gas flow through the plant without changes. The one-third/two-thirds split in the feed gas is controlled by a flow ratio controller.

Inlet temperature to the primary converter is maintained at 450°F. by adjustment of the bypass around the waste-heat boiler, which allows combustion gases from the reactor furnace to flow directly to the primary converter. Natural 2-4 mesh bauxite catalyst, supported by a stainless steel screen resting on cast iron grates, is used in the primary and secondary converter beds.

Since the reaction between H_2S and SO_2 to form elemental sulfur and water is exothermic, an increase in temperature occurs in the catalyst beds, with the outlet temperature of the gases from the primary bed being approximately 600°F. The gases then flow through the boiler feed water economizer, where they are cooled, and part of the sulfur make is removed as liquid sulfur prior to entry into the second bed.

Approximately 50% of the sulfur produced in the first bed is removed in the economizer. It drains by gravity through a steam-jacketed line to the sulfur sump. Adequate temperature control of the gases to the second converter bed is maintained by the use of the bypass around the economizer.

Better Reaction Rates

By removing the products of the reaction, an increase in the reaction rate and equilibrium conversion is attained in the second catalyst bed. Removing sulfur at this stage also lowers the sulfur dew point of the gas entering the second converter, thereby enabling this converter to operate at a lower temperature. Optimum operating temperature for this bed has been found to be 435-450°F., resulting in the maximum sulfur conversion without the formation of liquid sulfur in the catalyst. The balance of the reaction between H_2S and SO_2 occurs in this bed with a 10-20°F. increase.

Gases from the second bed enter the bottom of the sulfur wash tower, where the elemental sulfur is removed by a countercurrent stream of cooled liquid sulfur which cools the gas and condenses the sulfur vapors. Sufficient cooled sulfur is circulated to remove the heat of sulfur condensation and cool the gases without raising the temperature of the sulfur enough to put it into the highly viscous range.

The wash tower is packed with angle iron packing to promote intimate contact between gas and liquid sulfur. Water cooling coils, located in the bottom of the wash tower, cool the liquid sulfur to approximately 270°F. Flow of water through these coils is determined by the outlet temperature of the cooling water by means of a flow temperature controller.

Cooled sulfur is cycled back to the top of the wash tower while the excess flows from the bottom of the tower to the storage sump by gravity, where it is kept in a molten state by submerged steam coils. The sulfur sump is capable of storing four days' production, but present operations call for short hourly pump-outs to the solid storage facilities. In this

way, a solid block of pure sulfur is built consisting of many thin layers. This method of operation prevents the formation of liquid pools and it facilitates the breaking up with dynamite after the desired depth of sulfur is reached. Sulfur is also shipped in the molten state in steam coil-equipped tank cars.

Only one man per shift is required in the relatively simple, actual operation of this plant. The proper acid gas-air ratio to the furnace is controlled by a flow ratio controller which is regulated by the operator according to the results of his hourly tail gas analysis.

This analysis, a modified Tutweiler method, is the principal process control. It indicates the ratio of H_2S and SO_2 in the tail gas. The ratio is maintained at two mols of H_2S per mol of SO_2 for optimum plant conversion. An initial titration of a known volume of tail gas with standard iodine determines the total of the two gases present, and a subsequent titration of the resulting solution with standard caustic indicates the ratio of the two sulfur components.

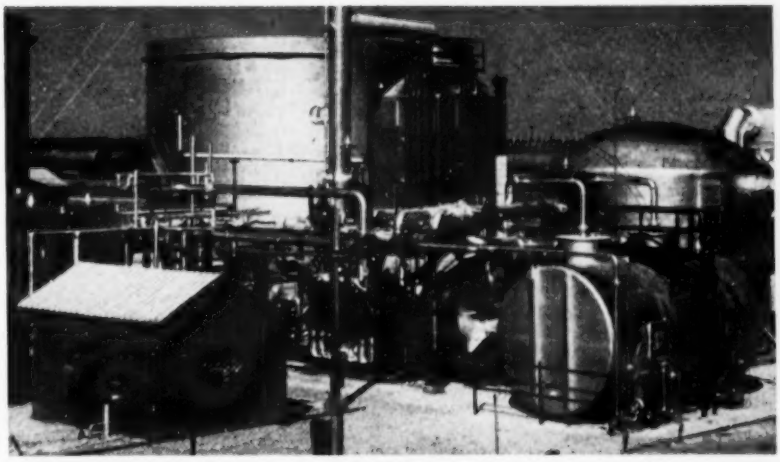
A furnace effluent gas sample is analyzed periodically for oxygen by the Orsat method. Less than 0.5 mol-% oxygen is desired, since a large excess of oxygen will promote combustion of H_2S and/or sulfur in the catalyst beds, resulting in a reduction in the overall plant conversion.

Self-Operating Unit

Once placed on automatic control, the sulfur plant is essentially self-operating by use of automatic controllers and properly located bypasses. A change in the quantity of acid gas being fed to the plant is immediately compensated by a corresponding change in the air blower speed, thereby maintaining the proper acid gas-air ratio to the reactor furnace.

Design flowing quantities of the various streams have been tabulated in Table 1.

Physical layout of this plant is such that a minimum of space is required. The entire unit and liquid storage facilities, including a "Fin-Fan" condenser and a control house, are contained in a 70 x 130-ft. area.



FRONT VIEW OF PLANT, showing from left to right: control house, waste heat boiler, and reactor furnace

The sulfur recovery unit is almost entirely self-supported insofar as power requirements are concerned. Steam turbines are utilized to drive the air blower, sulfur circulation pumps, boiler feed water pumps, and Fin-Fan unit.

During normal operations, the amount of 300 psig. steam produced is in excess of that required for operation of the sulfur plant and this excess is used in the treating plant facilities. The boiler feed water pumps are vertical, multi-stage "Hydroplex" centrifugals which take suction on the condensate receiver and discharge to the waste-heat boiler through the economizer.

The waste-heat boiler is a custom-designed, two-pass, fire tube type, equipped with a manual bypass to regulate the temperature of the exit gases. This plant is also equipped with a Fin-Fan unit which condenses the exhaust steam from the turbines and steam-jackted lines and returns the condensate to the condensate receiver. Pressure in the exhaust system from the Fin-Fan is controlled by a pressure controller regulating the steam supplied to the turbine driving the fan.

Every precaution has been taken to prevent the solidification of sulfur in lines and vessels. The wash tower is equipped with steam coils to keep the reflux sulfur in a molten state during prolonged shutdowns. The lines carrying liquid sulfur from the wash tower and economizer, as well as the product lines to the bulk sulfur pile and railroad siding, are all steam-jacketed.

The author wishes to express appreciation to the management of both the Stanolind Oil & Gas Co. and The Fluor Corp. Ltd. for permission to publish this article.

Table 1—Design Flowing Conditions, Sulfur Unit

Acid gas to furnace, M SCF/D	3,074
Acid gas bypassing furnace, M SCF/D	6,149
Total acid gas, M SCF/D	9,223
Air, M SCF/D	5,292
Wash tower, cooling water, lb./hr.	109,400
Steam from boiler, lb./hr.	15,674

Meet the Author

James F. Mullowney, research chemical engineer for The Fluor Corp. Ltd., Los Angeles, is a graduate of the University of Nebraska with a B.S. in chemical engineering. Before joining Fluor he was associated with Exchange Orange Products Co., Ontario, Calif., where he was assigned to the development of pharmaceutical products from oranges.

Mullowney joined the Fluor organization in 1950, and since that time has been involved in studies of gas treating and sulfur plant problems.

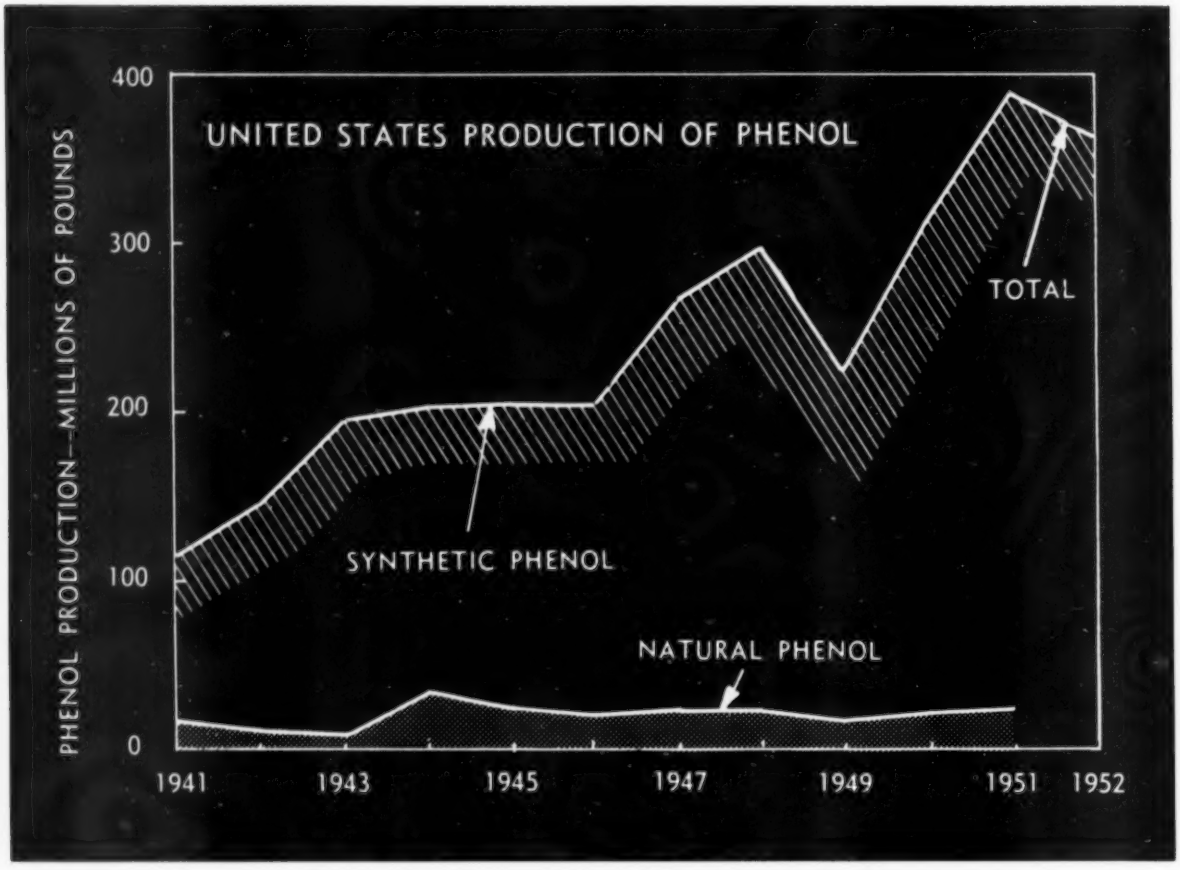


FIG. 1—Production trends for synthetic and natural phenol

Synthetic Phenol Manufacture

its sources, markets, and major processes—cumene, Raschig, sulfonation, chlorination

Part 1—Sources, markets, and the cumene route

By PETER W. SHERWOOD
Chemical Engineer, New York

BETWEEN the years 1950 and 1955, phenol production in the United States is expected to be doubled. Plans and construction are well underway to reach DPA's 1955 production goal of 623,000,000 lbs., up from 310,000,000 lbs. in 1950, 385,000,000 lbs. in 1951.

This is an industry in ferment. Following a period of relative stagnation, it has suddenly acquired a new production method, a large new market outlook, and new raw material sources.

The cumene hydroperoxide process for the synthesis of phenol has become an industrial reality during the 1950's. Based on propylene and benzene as raw materials, it brings phenol production wholly within the realm of petrochemical operations. The process was pioneered in this country by Hercules Powder Co. and is used in one version or another by Barrett Division and by Oronite Chemical Co. in the United States, and by B.A.-Shawinigan, Ltd. in Canada. Several other American and Canadian companies are known to show active interest in this process. A number of plants, based on this process, are also under construction in Europe where England's Distillers Co. has been in the forefront of its industrial development.

Equation (1) indicates the main steps involved in the synthesis of phenol via cumene hydroperoxide.

$$C_6H_6 + C_3H_6 \longrightarrow C_6H_5{\cdot}CH{\cdot}(CH_3)_2$$

$$\xrightarrow{(O)} C_6H_5{\cdot}COOH{\cdot}(CH_3)_2$$

$$\xrightarrow{\text{(acid)}} C_6H_5OH + CO{\cdot}(CH_3)_2 \quad \ldots (1)$$

The process competes with the more established methods for phenol production via benzene sulfonic acid and chlorobenzene. Its industrial advent was timed most opportunely and coincided with the peak of the sulfuric acid and chlorine shortages of the post-war years.

At this writing, the economics of the cumene hydroperoxide process are highly favorable. Net production costs of phenol via this route are influenced significantly by the price which can be obtained for by-product acetone. In the future, the price structure of this commodity will unquestionably be affected by the large volume in which acetone will become available as new phenol-from-cumene plants go on stream.

New sources of benzene supply are also available to the phenol producer. Since 1950, a growing portion of the market has been supplied by petroleum-derived benzene. In 1953, the petroleum industry is expected to account for some 110,000,000 gals. benzene[1a] or about 35% of the total demand in the United States which had previously been covered solely by the coal tar industry.

Markets for Phenol

Table 1[1] shows the end use pattern for phenol in 1951. This emphasizes the foremost position of the plastics and resins industry as a consumer of phenol. Sales in this field alone accounted for 232,000,000 lbs. in 1951.

Phenol serves as versatile intermediate in the chemical industry. Fastest-growing user is the weedkiller 2,4-dichlorophenoxyacetic acid (2,4-D) which rose from negligible production in 1944 to 40,000,000 lbs. in 1951 (calling for 23,000,000 lbs. phenol).

In second place is salicyclic acid, followed by pentachlorophenol, picric acid and others. Foremost among miscellaneous end uses for phenol is solvent extraction in the refining of lubricating oil. Consumption in this function is estimated at 12,000,000 lbs. in 1951.

A new development, the use of phenol-formaldehyde resins for shell molding, promises to effect a significant expansion in phenol demand. Low-cost techniques have recently become available in this field. A survey of their potential in foundry application indicates that shell molding may soon call for "several hundred million pounds" phenol per year[2]. Present rate of consumption in this field is 6,000,000 lbs. annually.

A number of other significant new outlets for phenol derivatives promises to enhance the market outlook even further. Among them might be mentioned the large potential for waste wood binders. This market accounts today for 10,000,000 lbs. annually. In the light of high wood prices, the demand for utilization of wood wastes is expected to result in an increase in phenol utilization amounting to 65,000,000 lbs./year by 1956.

Metal-coated phenol formaldehyde resins may soon play an important part in the production of such functional and ornamental parts as automobile grilles. This application must, however, await the development of techniques for the plating of the resin. Progress has been reported along these lines. According to the Chemical Week[2], perfection of this technique will result in new markets for phenol amounting to at least 180,000,000 lbs./year.

Other significant phenol markets in the making include rubber-phenolic compounds which can replace wood and metal in automotive parts, textile equipment, etc., and phenol resin binders for rock-wool and fibrous glass insulation.

Table 1—End Use Pattern for Phenol in 1951

(*millions of lbs.*)

		Amount	*Percent*
Phenolic resins		232	59.8%
Other chemicals		95	24.5
2, 4-D	23.0		
Salicylic acid	6.2		
Miscellaneous		40	10.3
Solvent extraction	12.0		
Exports		21	5.4
TOTALS		*388*	*100.0*

Phenol Sources

Before the advent of synthetic phenol manufacturing processes, the entire supply of this chemical was recovered in the course of coal tar processing operations. "Natural phenol" is therefore tied to the relatively gradual growth of the steel and coke industries, and demand has long since outrun this source of supply. As recently as 1940, natural phenol accounted for 25% of the market. By 1951, however, this proportion had been reduced to a mere 6%. Fig. 1 illustrates the growth of phenol production in the United States, indicating the relative decline of natural phenol over the years.

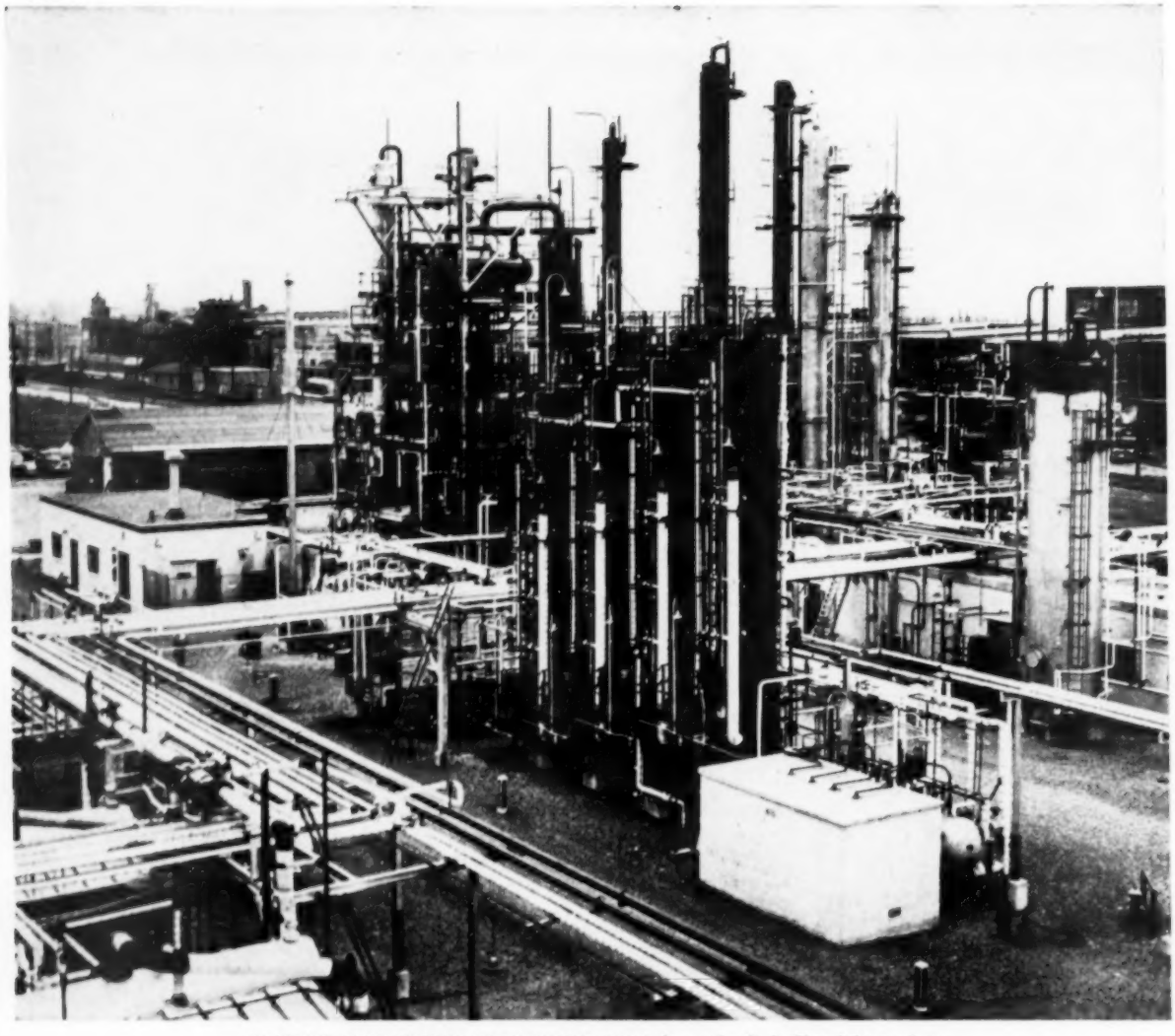
By 1941, three producers of synthetic phenol were operating in the United States. According to Weiss[3], plant capacities totaled 102,000,000 lbs.: Dow Chemical Co., Midland, Mich., accounted for 48,000,000 lbs.; Monsanto Chemical Co., St. Louis, Mo., 36,000,000; and Durez Plastics Co., Tonawanda, N.Y., 18,000,000.

Each of these manufacturers used a different method of synthesis, all of which are still commercially significant today. Monsanto employs the classical sulfonation process, while Dow relies on chlorination. A regenerative chlorination process, developed by Raschig, is used by Durez. These processes, together with the newly developed cumene hydroperoxide process, are the basis for the entire synthetic phenol production today and will be discussed in detail below.

Other methods of synthesis are available. A potential is seen in the production of phenol from cyclohexanol, produced by the air oxidation of cyclohexane. Cyclohexanol production is, of course, already a process of considerable commercial significance as intermediate step in the synthesis of adipic acid (which serves as raw material in Nylon production). Dehydrogenation of cyclohexanol to phenol can be carried out in good yield.

This process has a definite economic potential, although it is not yet employed industrially. Cyclohexane, its starting material, is already produced in large amounts from petroleum sources (mostly by isomerization of methyl cyclopentane) in the course of benzene manufacture.

This process illustrates strikingly



WORLD'S FIRST PHENOL-FROM-CUMENE UNIT is at the B.A.-Shawinigan plant in Montreal; view shows oxidation section

the large inroads made by the petrochemical industries into the traditional province of coal tar operations. As little as 10 to 12 years ago, considerable development work was directed toward the hydrogenation of phenol to cyclohexanol. Even today, some cyclohexane is still produced by the hydrogenation of benzene. This step is, however, receding into the background as increasingly adequate amounts of cyclohexane are made available to the industry by petroleum refiners (among them Shell, Humble and Phillips).

Much time and effort has been expended on the development of processes for the direct oxidation of benzene to phenol. Electric spark methods, high-pressure oxidation, and other syntheses have been attempted. Solvay Process Division has operated a direct oxidation pilot plant at Syracuse, N.Y. None of these attempts have been able to achieve sufficiently high yields to make the method economically attractive.

High-pressure hydrogenation of coal is today being practiced on a relatively small scale at Carbide and Carbon Chemical Co.'s Institute, W.Va. plant. The process is capable of yielding appreciable amounts of by-product phenols. It should be emphasized, however, that the bulk of tar acids produced by this method are substituted phenols, and that the yield of phenol itself is relatively small.

Actually, the concentration of phenols in the product of liquid phase hydrogenation is lower than in coal tar (obtained by the destructive distillation of coal). However, the liquid volume is, of course, much greater in the hydrogenation process so that the overall yield of phenol exceeds that obtained in coking operations.

In standard liquid-phase hydrogenation, it may be roughly stated that one ton of bituminous coal will yield 30 lbs. of phenol (carbolic acid) and 70 lbs. higher tar acids (cresols, and xylenols).[4] In addition, there will be phenolics with condensed nuclei. By modification of process conditions for the purpose of predominant production of chemicals, coal hydrogenation can be made to realize phenols in even somewhat higher yields.

The impact of coal hydrogenation on the phenol industry is hard to evaluate at this time. Investment and operating costs in the process are extreme-

ly high and large-scale development of this approach will have to await development of markets for the wide range of chemicals which are co-produced with phenol in the course of coal liquefaction.

Evidently, an eventual production of liquid fuels by the coal hydrogenation process will lead to the availability of very large amounts of by-product phenols. Based on the assumption that this approach will soon become a significant auxiliary source of hydrocarbon fuels, one section of the President's Materials Policy Commission Report[5] forecasts phenol production from coal hydrogenation at 50,000,000 lbs./yr. in 1955. By 1975, phenol derived from this process is predicted at 1,350,000,000 lbs., rivaling the production of 1,416,000,000 lbs. synthetic phenol.

At this juncture, it appears that this forecast for coal hydrogenation is optimistic. Total production of phenols by this route is reported at 3,000,000 lbs./year in 1953, and the outlook for coal hydrogenation as a source of synthetic fuels or of chemicals does not appear to be significant in the near future.

Synthetic phenol production has come a long way beyond the 1941 status of 102,000,000 lbs. annually. At the present time, installed capacity is estimated at 383,000,000 lbs./yr. while facilities for the production of 195,000,000 lbs./yr. are under construction. Table 2, due to Nieuwenhuis[1], summarizes the present synthetic phenol capacity in the United States.

Thus, it is seen that four processes serve to satisfy the entire national market for synthetic phenol. All of these methods are still competitive and facilities are now under construction to operate according to each of them. The remainder of this article series will be devoted to a discussion of technical and economic aspects of these four routes to synthetic phenol.

Table 2—Existing and Projected Synthetic Phenol Plants in the United States

(Capacity in million lbs.)

Company	*Location*	*Est. Capacity Operating*	*Est. Capacity Under Const.*	*Process*
Allied (Barrett Div.)	Frankford, Pa.	20	—	Sulfonation
Allied (Barrett Div.)	Frankford, Pa.	—	30	Cumene
Dow Chemical Co.	Midland, Mich.	150	40	Chlorination
Durez Plastics Co.	Tonawanda, N.Y.	35	30	Chlorination (Raschig)
Hercules Powder Co.	Paulsboro, N.J.	—	15	Cumene
Monsanto Chemical Co.	St. Louis, Mo.	70	—	Sulfonation
Monsanto Chemical Co.	Avon, Calif.	—	30	Sulfonation
Oronite Chemical Co.	Richmond, Calif.	—	35	Cumene
Reichhold Chemicals	Tuscaloosa, Ala.	48	12	Sulfonation
Carbide / Carbon	Marietta, Ohio	60	—	Chlorination
Carbide / Carbon	Institute, W.Va.	—	3	Coal hydrogenation
TOTALS		*383*	*195*	

Phenol Via Cumene Hydroperoxide

This is the new method of phenol synthesis which promises to reconstitute economic relationships in the production of phenol, acetone, and isopropyl alcohol.

The process is carried out in accordance with Equation (1). It should be noted that the synthesis is suitable for the manufacture of substituted phenols by using an alkylated benzene as starting material. It serves Hercules Powder Co. for the production of cresol (i.e. methyl phenol) from toluene.

The cumene route to phenol involves three fundamental chemical steps: Isopropylation of benzene, autoxidation of cumene, and decomposition of cumene hydroperoxide.

(a) Isopropylation of Benzene: Production of cumene from benzene has been practiced in the petroleum industry for over ten years. The process was particularly significant during World War II when cumene was used extensively as a component of aviation fuels.

Two processes have served in the commercial production of cumene. Most important is the vapor-phase reaction of propylene with benzene in the presence of orthophosphoric acid catalyst on a kieselguhr carrier. At least one large plant (at Curaçao, N.W.I.) has employed a liquid-phase alkylation, involving sulfuric acid catalysis, and following lines which are today widely accepted in refinery practice for the alkylation of alkanes. This is also the method followed at B. A. Shawinigan, Ltd., which took its phenol plant on-stream in May 1953.

A commercially successful method for the vapor phase alkylation of benzene has been developed by Universal Oil Products Co. The phosphoric acid-kieselguhr catalyst employed assays 62-65% P_2O_5 and 25% SiO_2.

To prevent premature dehydration and deactivation of this catalyst, a small amount (less than 0.1%) of water must be introduced with the feed, either as such or in the form of isopropyl alcohol. Sulfur compounds, notably thiophene, should be substantially absent (less than 0.15%) from the feed benzene because of their deleterious effect on catalyst life.

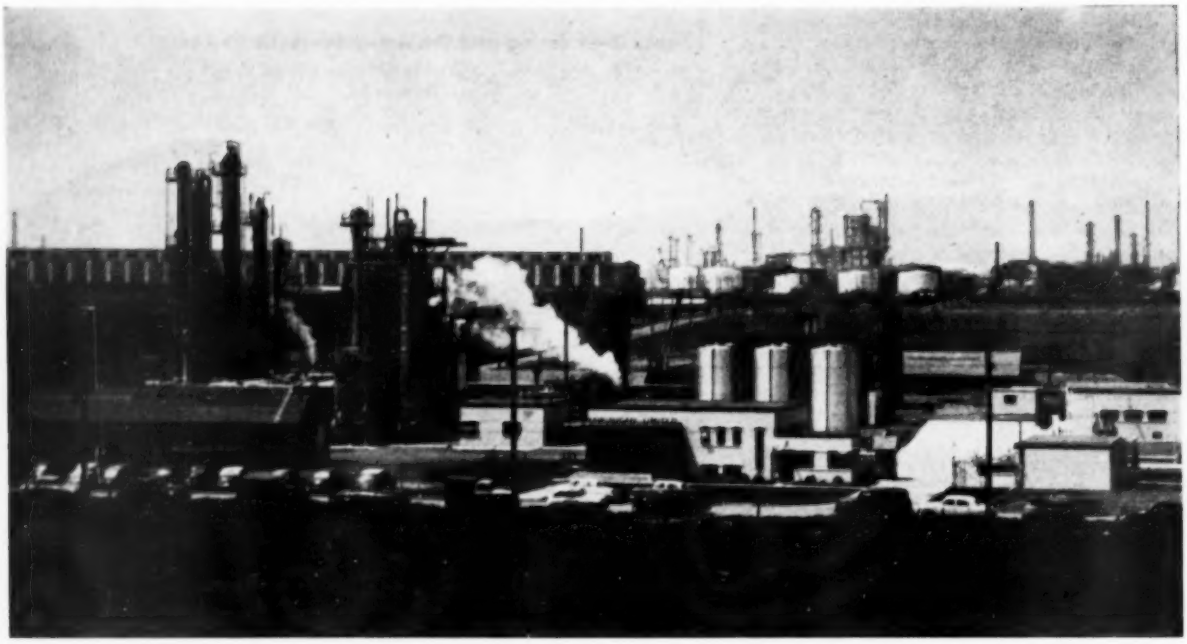
Fixed-bed reactors are employed. Benzene (both make-up and recycle) is mixed with propylene feed and the mixture is charged to the reactors via a set of heat exchangers. Suitable cooling coils are provided in the catalyst bed to abstract the exothermic heat of alkylation.

Reactor make, leaving the bottom of the converters is cooled in heat exchange with the incoming feedstream. Its pressure is then reduced from reactor level (250-400 psi.) to some 165 psi., which is operating pressure in the depropanizer column.

The bottoms leaving this primary separation column enter the benzene recycle column. Overhead from this unit is returned to the reactor feed tanks. The bottoms are finally fractionated into pure cumene product and a bottoms fraction of polyalkylated benzene. Di-isopropyl benzene may be recovered from this fraction and recycled to the converters where some disproportionation of the dialkyl benzene will raise the overall yield of cumene. Because the yield improvement is small and the effect on catalyst life is adverse, this recycling is not generally carried out in vapor-phase operation, however.

The alkylation reaction will proceed with equal ease with benzene as with its alkylated derivatives. Product concentration in the reactor must therefore be maintained at a low value lest the formation of yield-consuming poly-alkyls becomes excessive. This consideration is of outstanding importance in the vapor-phase process in which polyalkylated benzene may normally not be recycled for reasons stated above.

To maintain the desired low product concentration within the reactor, a high ratio of benzene:propylene is employed. Work by McAllister[6] illus-



GENERAL VIEW of the new Canadian plant for synthesizing phenol from cumene, recently placed on stream at Montreal East

trates the effect of changing this variable. Thus, the cumene concentration of the alkylate (after benzene removal) was found to average 90% over a wide range of operating temperature, pressure, and space velocity, when the benzene:propylene ratio was held at 5.0.

A reduction in this ratio to 3.5 resulted in an 87% cumene content of the alkylate. A nearly asymptotic maximum yield is obtained at a reactants ratio slightly above 5.0. This, then, is the ratio provided in normal cumene production. Excess benzene is recovered from the reactor make and is recycled to the process.

Operating temperature (at a normal operating pressure of 250 psi.) is limited to a lower level of the 200° C if vapor phase conditions are to be maintained. Temperatures above 300° C have a damaging effect on the catalyst. Preferred operation is in the range of 270° C.

Operating pressure is in the range of 250 to 400 psi. The effect of raising the pressure is principally that it permits higher throughput per unit reactor space. The limitation is (a) the increased cost of reactor equipment above approximately 450 psi., and (b) the permissible maximum temperature of 300° C which determines in its turn the maximum pressure at which the system will still be wholly in the vapor state.

Pressure, temperature, and level of catalyst activity determine the permissible space velocity. Operating range is at or about 2.5 LHSV. Increase in temperature, pressure, or catalyst activity necessitates a corresponding reduction in space velocity (thus raising the contact time and lowering effective throughput).

Overall cumene yield is of the order of 90-93%, based on benzene. Propylene is not recycled and its conversion is substantially complete in a single pass.

(b) Autoxidation of Cumene: The original work on which the production of phenol from cumene is based, is credited to Hock and Lang.[7] These authors showed that isopropyl benzene peroxide is formed when dry cumene is subjected to air oxidation in the presence of ultraviolet radiation. The oxidized reaction mixture, upon treatment with aqueous alkali and subsequent acidification, will yield phenol plus acetone.

Hock and Lang operated with oxidation conversions of only 7%. Attempts to raise oxygen conversion above this level resulted in rapid decrease in sodium phenate yield upon decomposition. The rate of oxidation obtained by the original technique was discouragingly slow.

An industrially feasible solution came with the work of Armstrong [8,9,10] and others who found that the oxidation rate could be greatly expedited and benzene peroxide formation could be greatly improved by carrying out the reaction in a dispersion of the hydrocarbon in an alkaline aqueous phase.

If the aqueous medium is neutral or acidic, the oxidation rate is of the same order of magnitude as is obtained in the autoxidation of the homogeneous hydrocarbon phase. The use of high alkalinity is not suitable because of its adverse effect on hydroperoxide yield. The optimum conditions are found to be at pH of 8.5-10.5, a condition which can be readily maintained by the use of sodium carbonate as buffer.

To obtain the best conditions, an emulsifying agent must be employed in conjunction with thorough stirring. The choice of emulsifying agent influences the reaction progress significantly. For example, at a peroxide concentration of 10%, oxygen was absorbed at the rate of 2 moles/100 moles cumene per hour when the emulsifying agent was 0.4% Teepol (mixed sodium alkyl sulfates).

This rate was improved to 3.2 when the emultifying agent was sodium stearate in 0.3% concentration. Indeed, this effect becomes even more pronounced as the peroxide concentration rises. It should be noted that the concentration of any one emulsifying agent can be varied over a wide

range with only little influence on the oxidation range.

Of equal importance is the volume ratio of water and oil phases. At a 20% peroxide concentration, the oxygen absorption value was found to be 3.2 at a water-oil ratio of 1.0. This rose to 4.5 and finally to 5.8 as the ratio was increased to 2.0 and then to 5.0. In commercial practice, the optimum phase volume ratio is set by economic compromise between the greater oxidation rate per mole of hydrocarbon present and the reduced conversion velocity obtained per unit reactor volume.

The reaction takes place readily at mild conditions (atmospheric pressure, 85° C). While air may be employed as oxidizing agent, the use of oxygen offers the advantage of higher partial pressure and consequent improvement in reaction rate in this heterogeneous system. Unconverted oxygen may be recycled to the reactor and its utilization is high (in excess of 90%).

Yield of hydroperoxide is almost quantitative during very early stages of the reaction. As the concentration of peroxide in the system increases, a portion of it is destroyed by further oxidation, resulting in an overall decrease in yield. At a 20% hydroperoxide concentration, yield is of the order of 90%.

The oxidation reaction is autocatalytic; i.e. the hydroperoxide serves as catalyst. Thus, it is found that there is an induction period of approximately 1.5 hours at the start of the reaction. During this time, oxygen absorption is practically nil. This induction period can be eliminated by the addition of cumene hydroperoxide at the beginning of the reaction. Other peroxides (benzoyl, lauryl) have the same effect.

Once the reaction has been initiated, conversion rate increases gradually as the peroxide concentration in the cumene phase rises. This continues up to 30-35% (or less, if a less efficient emulsifying agent is used). Above this value, a decline in oxidation rate is observed, although it is possible to continue the oxidation up to 47-50 mole-% peroxide content, and probably even beyond this point.

At the same time, yield continues to decrease as the peroxide concentration is allowed to build up in the system. The actual conversion taken per pass is therefore arrived at by economic compromise; it is in the range of 25 to 40%.

A number of chemical impurities tend to act as inhibitors to the reaction and their absence from the hydrocarbon feed must be assured. Most objectionable is the presence of phenol, while styrene and alpha-methyl styrene have been shown to retard the reaction.

The crude oxidation product is converted directly to phenol, without intervening purification. However, several methods are at hand for the recovery of the hydroperoxide, if desired.

A crude mixture of the peroxide and hydroperoxide may be obtained by distilling off the unconverted hydrocarbon in vacuo. Alternately, they may be extracted from the separated oily layer of the reaction product by means of dilute aqueous alkali solution.

Treatment with concentrated sodium hydroxide solution will result in the precipitation of the sodium salt of the hydroperoxide in solid form. A small portion of the product is, of course, contained in the aqueous layer provided during the reaction stage. This can be extracted by means of a hydrocarbon solvent after partial acidification.

(c) Decomposition of Cumene Hydroperoxide: Conversion of the hydroperoxide to phenol can be readily accomplished by heating the liquid reaction mixture with acid. By working at slightly elevated pressure, the operating temperature can be raised with consequent increase in reaction rate. By operating at the boiling point of the mixture, by-product acetone can be removed overhead as it is formed.

Dilute sulfuric acid answers the demands of the process well and is the preferred medium, while other acids such as phosphoric, acetic, etc., may also be used. The concentration influences decomposition rate significantly. For example, a 10% sulfuric acid solution is able to complete conversion in one hour under conditions which necessitate 5 hours' contact time with a 1% acid concentration.

The reaction is found to proceed more satisfactorily and rapidly with the peroxide contained in the crude reaction mixture than with isolated hydroperoxide. In the production of phenol, the crude product is therefore charged to the acid treatment stage as such. The presence of cumene serves as solvent for by-products which occur in the system and this prevents obstruction by their decomposition in the reaction vessel.

Since the reaction system consists of two heterogeneous phases (unless an organic acid is employed), the efficiency of stirring is of significant influence on the reaction progress. This effect is illustrated as follows[11]:

Time (Minutes)	*% Decomposition*	
	Stirred	*Unstirred*
10	50	26
20	68	38
30	78	46
40	85	57
50	89	61
60	93	76
90	96	84
120	97	91

Overall phenol yield is of the order of 70-80%, calculated on the total per-compounds present in the crude reaction mixture. Typical product composition is 9.1% acetone, 15.2% phenol, 0.84% acetophenone, 1.5% alpha-methyl styrene, the remainder being cumene.

(d) Purification of Products: Acetone is removed from the reaction system in the course of acid decomposition at the mixture's boiling point. Phenol must be recovered from the liquid product. Cumene must also be recovered for recycling purposes. This hydrocarbon must be freed completely of any contained phenol which acts as inhibitor in the oxidation stage. Also present are small amounts of alpha-methyl styrene and other objectionable compounds which are formed in the course of the chemical reaction steps and which must be removed before the cumene stock may be recycled.

A suitable purification process has been described by Distillers' Co., Ltd.[12] Acetone is separated from the reaction product by distillation (partly in the course of the decomposition stage, and partly by fractional distillation of the liquid product).

The bottoms of the acetone still are extracted with water at 70-90° C (weight ratio water:crude product is approximately 6.0). This will remove most of the phenol and about one-quarter of the acetophenone from the reaction product. Cumene in the raffinate is freed of residual acetophenone by distillation and of methyl styrene by mild hydrogenation. It is then sufficiently pure to permit its return to the oxidizer feed tanks.

The aqueous extract is contacted with butyl acetate. This will remove 99% of the contained phenol, while acetophenone will remain in water solution. Some butyl acetate is recovered by distillation from the aqueous phase in which it is dissolved in 0.5% concentration.

Phenol content of the butyl acetate layer is of the order of 40%. The solvent is removed in a distillation step, leaving phenol with a residual acetophenone content of approximately 1.5%. By a final fractionation, phe-

nol is rendered in commercially pure form, substantially free of acetophenone. Recovery is approximately 95% of the phenol leaving the decomposition stage.

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Do You Know These Words?

By B. H. WEIL
Head, Information Division
Ethyl Corp. Res. & Engrg. Div.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Phenol

PHENOL, also known as carbolic acid, is an important industrial chemical which has recently moved steadily from among "coal-tar" products to a place in the firmament of petrochemicals. Pronounced "**fee**-noll," and having the formula C_6H_5OH, it is a white, crystalline chemical which turns pink or red if not pure or if exposed to air and light. When exposed to air, also, it absorbs water from it and liquefies. It is a strong, corrosive poison of sharp, burning taste and distinctive odor; it melts at 109°F and boils at 320°F.

While some phenol continues to be extracted from a coal-tar oil fraction, most of it is synthesized from benzene by a variety of processes, including reaction with sulfuric acid, reaction with hydrochloric acid and air, reaction with chlorine, and direct oxidation. The most recent commercial process involves the alkylation of benzene with propylene to yield isopropylbenzene (cumene), which is oxidized to cumene hydroperoxide and the latter then split apart catalytically to yield phenol and acetone simultaneously.

Phenol finds its chief use in the manufacture of the much-used phenol-formaldehyde and related plastics, which are employed for molding, for laminating, in adhesives, in protective coatings, etc. It is also extensively used in the manufacture of such chemicals as weed killers, dyes, and detergents; as a selective solvent in the refining of lubricating oils; and as a pharmaceutical (germicide, antiseptic, etc.).

Petroleum is taking over as a raw material in several ways. Benzene is now being extracted in increasing quantities from catalytic reformates. Propylene, used in the latest method of phenol synthesis, is extracted from cracked refinery gases or deliberately prepared from refinery or natural gases. Even sulfuric and hydrochloric acids are today refinery products in many instances. Judging simply from the number of plants being constructed to produce phenol by the new cumene process, phenol will continue to be produced in large or increasing quantities, and in large part from petroleum.

Tricresyl Phosphate

TRICRESYL PHOSPHATE, pronounced "'try-**kress**-ill **fahs**-fate," is a chemical which, while still based in large part on coal-derived cresylic acid, is depending increasingly on petroleum cresylic acid as a raw material for its expanding production. It is a stable, nonvolatile, odorless, practically colorless, oily liquid; has quite a high boiling point (nearly 800°F); has a pour point of around 0°F; and is insoluble in water although soluble in most common solvents. It has the formula $(CH_3C_6H_4O)_3PO$.

Tricresyl phosphate is commonly prepared by the reaction of cresol or cresylic acid (mixed cresols) with phosphorus oxychloride or phosphorus pentachloride. The properties of the final product depend upon the composition of the cresylic acid employed. Rigorous purification is needed to free the final product of odiferous and corrosive phenolic compounds.

As recently as 1947 almost all the tricresyl phosphate produced was used as a plasticizer for nitrocellulose, ethyl cellulose, and vinyl resins in such uses as artificial leather, adhesives lacquers, and plastics. The plasticizer market is expected to continue to absorb the majority of near-future production, but increasing quantities are being consumed as gasoline and lubricant additives, hydraulic fluid, fire-retarding agents, etc.

Petroleum cresylic acids, already used by at least one manufacturer of tricresyl phosphate, are recovered from cracked distillates, such as heavy catalytic naphthas and cracked heating oils, by treating with dilute caustic soda, followed by purification of the extract to give a marketable product. If and as the production of tricresyl phosphate expands, petroleum will play a correspondingly increasing part.

Methylamines

METHYLAMINES — monomethylamine, CH_3NH_2; dimethylamine, $(CH_3)_2NH$; and trimethylamine, $(CH_3)_3N$— are low-cost petrochemicals which today are receiving increasing attention because of their versatility and because they are the most economical amines currently available. Pronounced "**meth**-ill-ah-**means**," they are clear, colorless gases at room temperature. Since they liquefy at relatively low pressures at ordinary temperatures, they are normally handled in the compressed liquefied state; they are also sold as solutions in water. These chemicals have strong ammoniacal odors.

All three methylamines are produced by reacting methanol and ammonia at high temperatures over a catalyst, the ratio of the amines produced being controlled, as desired, by the ratio of ammonia to methanol and by the temperature.

Present and potential uses of the methylamines are legion. They are raw materials for dyes, drugs, and pharmaceuticals; detergents; vulcanization inhibitors; and fungicides and insecticides. They are used in tanning, and in the unhairing of hides. As solvents, catalysts, accelerators, and polymerization inhibitors they have specific applications.

Both of their raw materials, methanol and ammonia, are full-fledged petrochemicals, relying in turn upon natural and refinery gases for their synthesis. Judging from the extent of recent advertising by several producers, the methylamines will be receiving increasing attention as time goes on.

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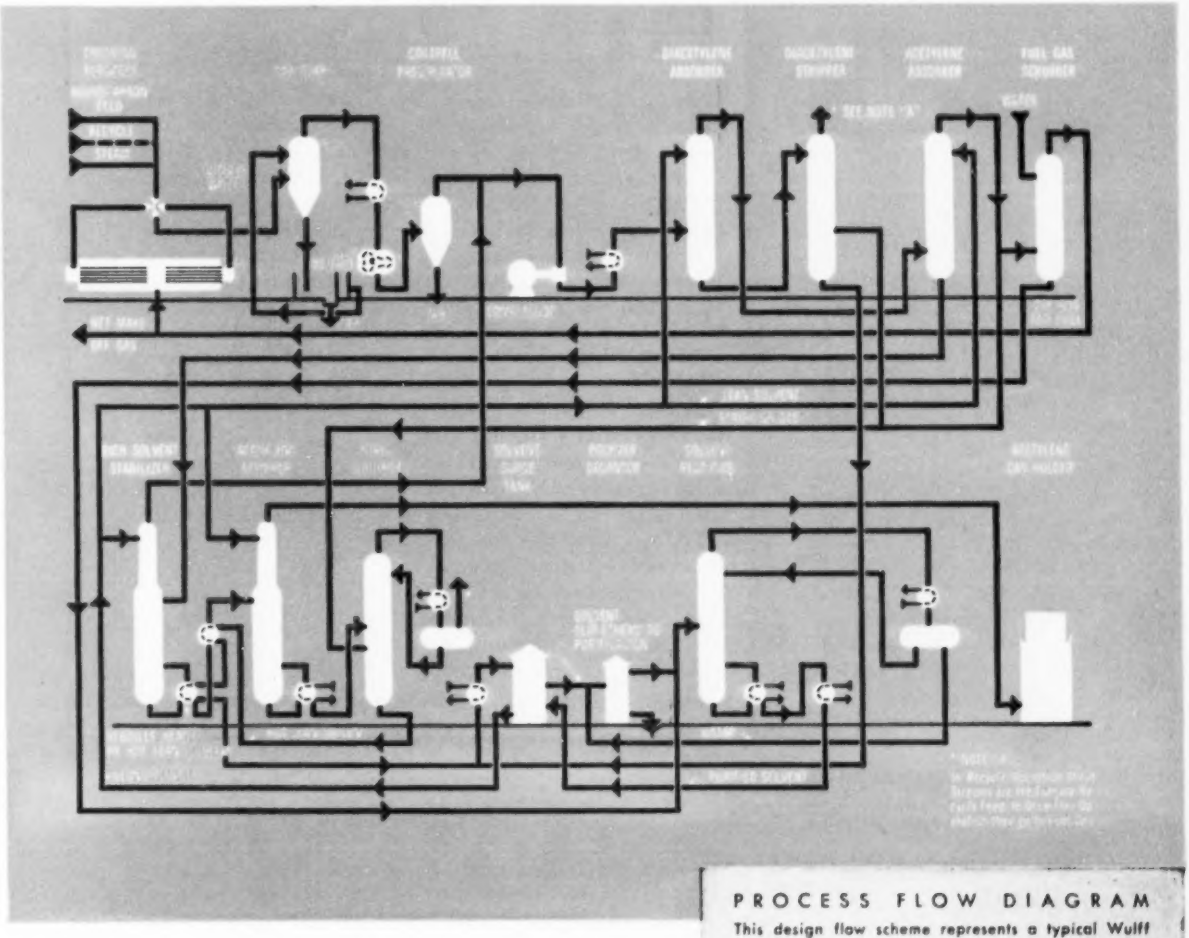

PROCESS FLOW DIAGRAM

This design flow scheme represents a typical Wulff Process plant for producing low-cost acetylene at 99+ volume percent purity from natural gas or propane. Two basic steps are involved: cracking of hydrocarbons to produce acetylene in a mixture of gases, and recovery and purification of the dilute product contained in the cracked mixture. Feed hydrocarbon is cracked in regenerative type furnaces heated by air-combustion of off-gas from the recovery section. No oxygen plant is required. The recovery and purification section is of conventional design operating at moderate temperatures and pressures. Only a single inexpensive readily-available solvent need be used. Operation is continuous and virtually automatic, requiring a minimum of operating personnel. Power demands are moderate, maintenance costs are low, hazards are negligible and there is practically no waste disposal problem.

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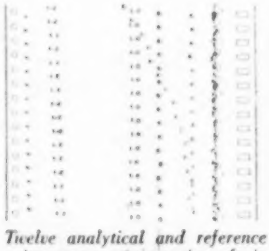

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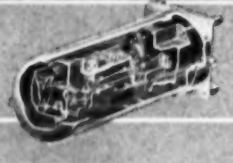

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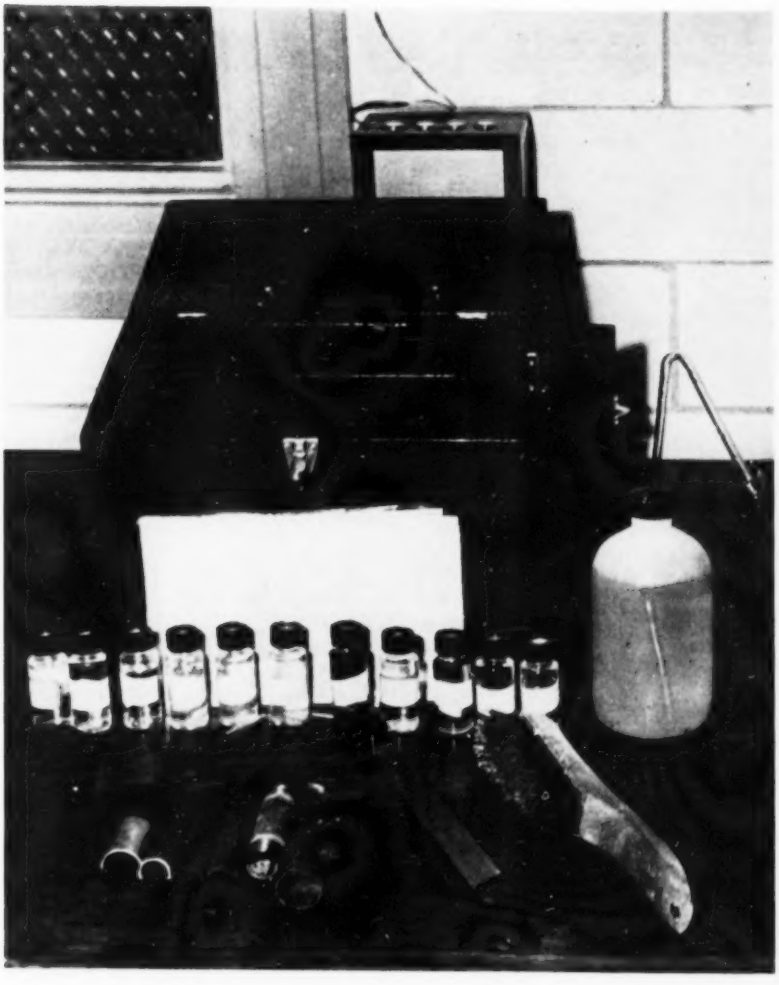

Field Kit Speeds Metal Identification

By MAXEY BROOKE
Phillips Petroleum Co.
Sweeny, Texas

A refinery inspection department is frequently called upon to make field identification of metals because conditions are often such that laboratory tests are not possible.

In a field test kit for this purpose, the tests provided for and supplied by the kit should be fast and simple, yet of sufficient number to answer the most frequent questions arising in metals identification; questions such as:

1—Is this a light alloy; aluminum or magnesium?
2—Is this a yellow alloy; inhibited or uninhibited admiralty?
3—Is this a heavy white alloy, iron or nickel?
  a—If nickel, is it Monel or Inconel?
  b—If iron, is it steel, chromium steel, or chrome-nickel steel?
  c—If chromium steel, what is the % chromium?
4—Does this steel contain molybdenum?

The field test kit illustrated in the accompanying photograph has been designed by the author and experience has proved its value. In addition to reagents and a number of accessories, it contains a set of inspection cards for the various field tests for which the kit is equipped.

The tests as described on these cards are over-simplified and will not give accurate quantitative results under all conditions since many results will vary with the temperature and carbon content of the metals. In some cases, the alloying elements will vary over the length of the metal sample so that several tests will be needed to form a reliable opinion. However, with experience and, particularly, by comparing the field tests with tests on known specimens, a considerable number of metals may be identified easily and quickly. The accompanying references may be reviewed for greater detail regarding the limits and accuracy of the tests used.

The kit contains the following reagents in one-ounce dropper bottles:

1—0.5% silver nitrate.
2—10% hydrochloric acid.
3—Concentrated nitric acid.
4—47% nitric acid.
5—35% nitric acid.
6—10% nitric acid.
7—10% potassium ferricyanide.
8—20% cupric chloride.
9—10% ammonium thiocyanate.
10—20% sodium thiosulfate.
11—Dimethyl glyoxine solution (1 g. DMG in 10 cc. 98% ethyl alcohol and 10 cc. ammonium hydroxide).

In addition to the chemicals, the following accessories are in the kit: polyethylene wash bottle of distilled water, file, wire brush, magnet, filter paper, magnifying glass, 6-volt battery, specimens, and instructions. The specimens are the various metals which may be encountered. They are particularly useful to the inexperienced operator for making comparison tests.

Instruction cards read as follows:

1—To distinguish between *aluminum* and *magnesium:* Place one drop of silver nitrate solution on the metal. Observe after one minute. A black deposit indicates magnesium or a high magnesium alloy. No action indicates aluminum.

2—To distinguish between *inhibited admiralty* and *uninhibited admiralty:* Place one drop of cupric chloride on the metal. Observe after 30 seconds. A black film indicates the inhibited admiralty. A grey or pink film indicates the uninhibited admiralty.

3—To distinguish between *steel* and *nickel alloys:* Add one drop of 10% hydrochloric acid and allow to

Table I—Data for Determining Percent Chromium

Percent Chrom.	*Solution*	*Reaction*
0-1%	Conc. HNO_3	Turns light green immediately
	47% HNO_3	Turns dark brown, vigorous reaction
	35% HNO_3	Turns dark brown, vigorous reaction
2%	Conc. HNO_3	Remains clear
	47% HNO_3	Turns dark brown, vigorous reaction
	35% HNO_3	Turns dark brown, vigorous reaction
5%	Conc. HNO_3	No reaction
	47% HNO_3	Turns dark brown, then becomes clear
	35% HNO_3	Turns dark brown
7%	Conc. HNO_3	No reaction
	47% HNO_3	No reaction
	35% HNO_3	Turns dark brown, then becomes clear
9%	Conc. HNO_3	No reaction
	47% HNO_3	No reaction
	35% HNO_3	Very slight reaction, leaves a light stain after one minute
12%	Conc. HNO_3	No reaction
	47% HNO_3	No reaction
	35% HNO_3	No reaction

react for one minute. Add one drop of potassium ferricyanide to the hydrochloric acid and observe after 30 seconds. A dark green to blue color indicates a steel alloy. A colorless, red, light green, or brown color indicates a nickel alloy.

3A—To distinguish between *nickel-chrome stainless steel* and *non-nickel steel:* Test with the magnet. Strongly magnetic metal is steel or chrome steel. Faintly magnetic or non-magnetic metal is nickel-chrome stainless steel. Add one drop of dimethylglyoxine. A red color indicates nickel steel. The red color can be made more clearly visible by rubbing a piece of filter paper on the stain.

3A(1)—To determine the approximate per cent *chromium in the steel:* Add one drop each of concentrated nitric acid, 47% nitric acid, and 35% nitric acid. The chromium per cent can be determined by the data in Table 1, indicating reaction results.

3B—To distinguish between *Monel* and *Inconel:* Add one drop of concentrated nitric acid. Reaction forming a blue color indicates Monel or cupro-nickel. No reaction indicates Inconel.

4—To determine *if an alloy contains molybdenum:* Put a drop of 10% nitric acid on a piece of filter paper and place on the metal. Connect positive terminal of 6-volt battery to the metal and the negative terminal to the aluminum backer which is, in turn, placed on the filter paper. Allow current to flow for one minute. Remove filter paper and back up with four more sheets. Add one drop af 10% hydrochloric acid to the wet spot. Add one drop of ammonium thiocyanate. A deep red color will form. Add one drop of sodium thiosulfate. The red spot will disappear except for the outer extremity. An inner halo of pink, separated from the red, indicates molybdenum.

Mr. Brooke, contributor of the preceding short article, is supervisory chemist, Phillips Petroleum Co.'s Sweeny, Texas, refinery.

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You Save When You Classify Your Maintenance Costs

IN the continuing battle to reduce costs of maintenance operations, it is wise to consider carefully the proper classification of these costs depending upon who is seeking information—top management or the plant engineer or the maintenance superintendent. This is the conclusion reached by one large Eastern chemical manufacturer.*

In general, top management considers maintenance an integral part of production and a factor in the quality and quantity and cost of the product. The plant engineer has to know considerably more detail, so as to plan his preventive program, replacement of equipment, manpower requirements, etc.

How should some of this information be classified—for example, machinery and equipment—for the superintendent of maintenance? And once classified and summarized, what good is it to the maintenance superintendent?

Equipment maintenance expense ought to be segregated by equipment types, such as motors, blowers, piping, etc., this chemical company has found. These items in turn can be subdivided into various manufacturing departments; eventually, if possible, into actual numbers of pieces of equipment. The charges can also be separated into labor, materials, and overhead.

Four Purposes

When calculated and summarized on conventional office accounting machines, this kind of information will serve a number of purposes:

1—If summarized for a single piece of equipment, it may highlight the need for replacement of one unit.

2—If summarized for equipment types, it may indicate where a major effort is needed on long range studies.

3—If summarized by manufacturing department, it may indicate some need exists for special educational or corrective programs. This kind of summary also makes available to the production supervisor an indication of his performance.

4—The ratio of material to labor might be used as a rough index of labor efficiency.

Top management, on the other hand, in this company is not concerned with this kind of detail. What it wants to know generally is information on what part of the sales dollar is chargeable to maintenance and repair. Or, it may wish to know what percentage of invested capital is involved in main-

* "Classification of Maintenance Costs," by C. E. Knight, plant engineer, Monsanto Chemical Co., Plastics Div., Springfield, Mass., presented at the Third Plant Maintenance Conference and Show, Philadelphia, Penna.

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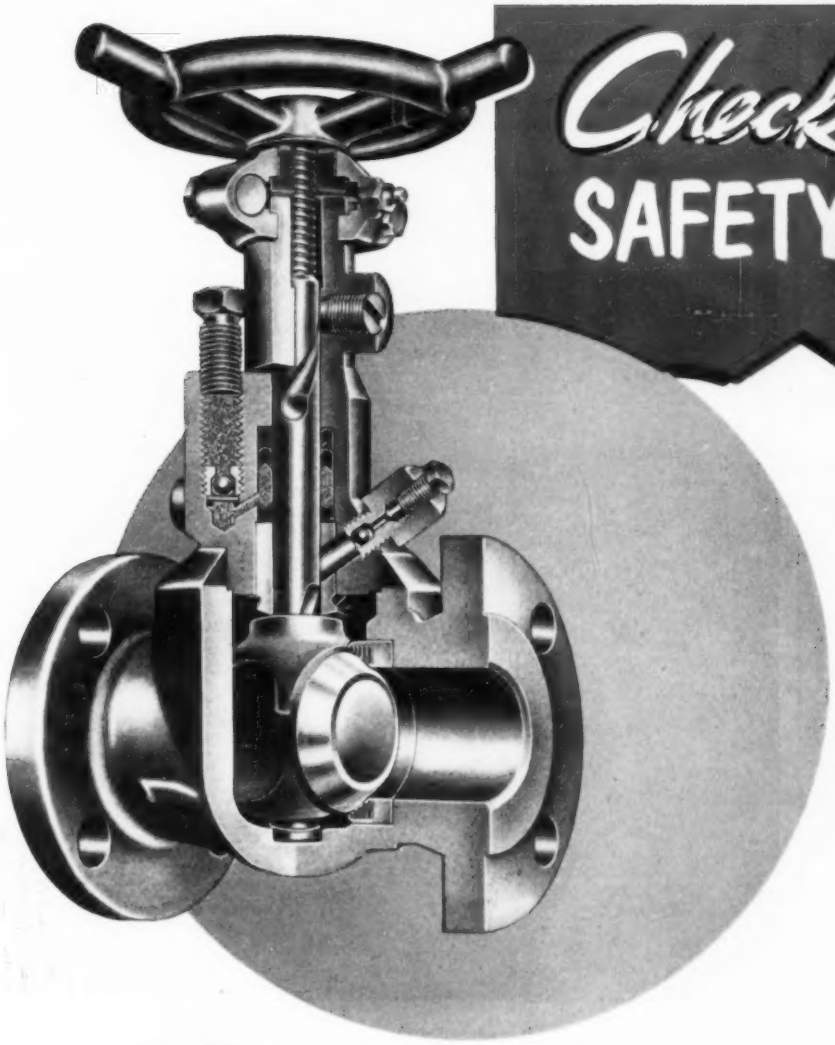

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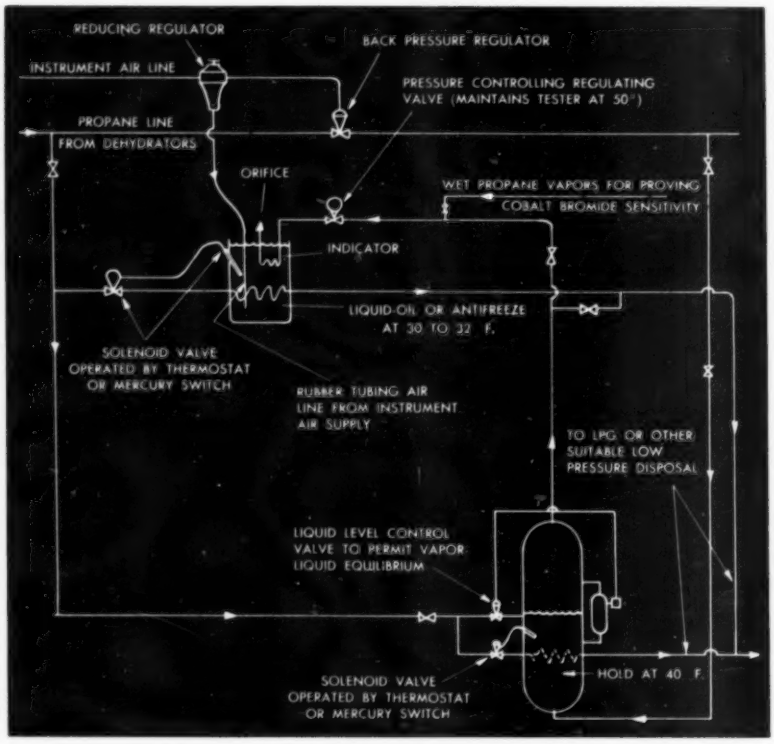
tenance, or cost per unit of production, or simply gross expenditure figures.

For an everyday, routine check on the way maintenance operations are going, the details as outlined above for plant engineer or maintenance superintendent are the kind of details that will help a plant cut maintenance costs.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Continuous Propane Dryness Tester

A conventional cobalt bromide test method can be adapted for use on a continuous basis as a piece of plant instrumentation. When installed so as to take samples from a small side stream, say of liquid propane from the rundown line to storage, it will serve as a continuous test to make certain propane meets dryness specifications.

As shown in the accompanying sketch, the unit consists of two essential parts. The first includes a small vaporizing chamber with a controlled liquid level and temperature which allows the propane liquid and vapor to reach equilibrium at a temperature of 40° F. The second is the modification of the conventional dryness tester, in which the bath is maintained at a constant uniform temperature of 30 to 32° F. by use of a coil through which liquid propane is expanded and by use of an open air line extending to the bottom of the bath. A pressure controlling regulator maintains the 50 psi. pressure required by the conventional tester itself which is immersed in the bath. A solution of anti-freeze is used in place of water in the bath.

In operation, liquid propane enters the vaporizing chamber. Vapors pass Through the pressure regulator to the cooling coil, contact the cobalt bromide indicator and exhaust through the orifice to the atmosphere. If the indicator remains blue or green the propane is said to meet dryness specifications. For an occasional check on the sensitivity of the indicator, a line is provided to admit wet propane vapors to the tester.

The preceding short item is based on a prize-winning "Plant Kink" from a regional meeting of the Natural Gasoline Association of America in Odessa, Texas, last year. It was contributed by W. L. Covington, chemist, and W. A. Allerson, assistant superintendent, Shell Oil Co., Notrees, Texas.

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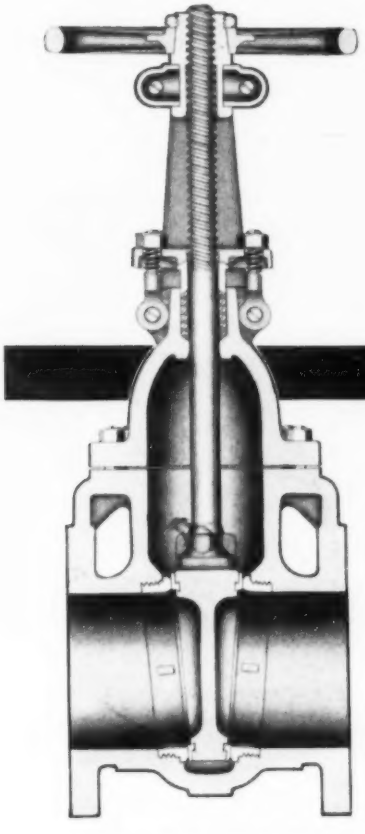

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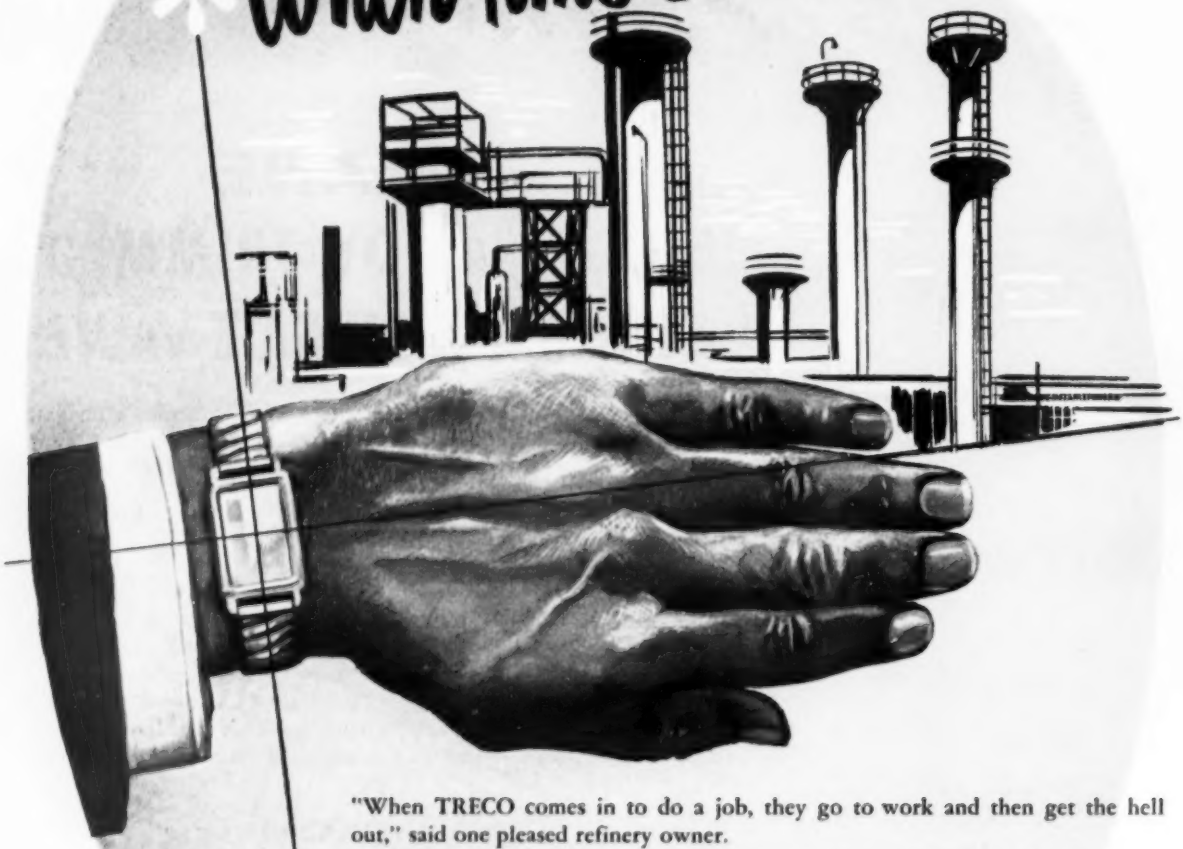

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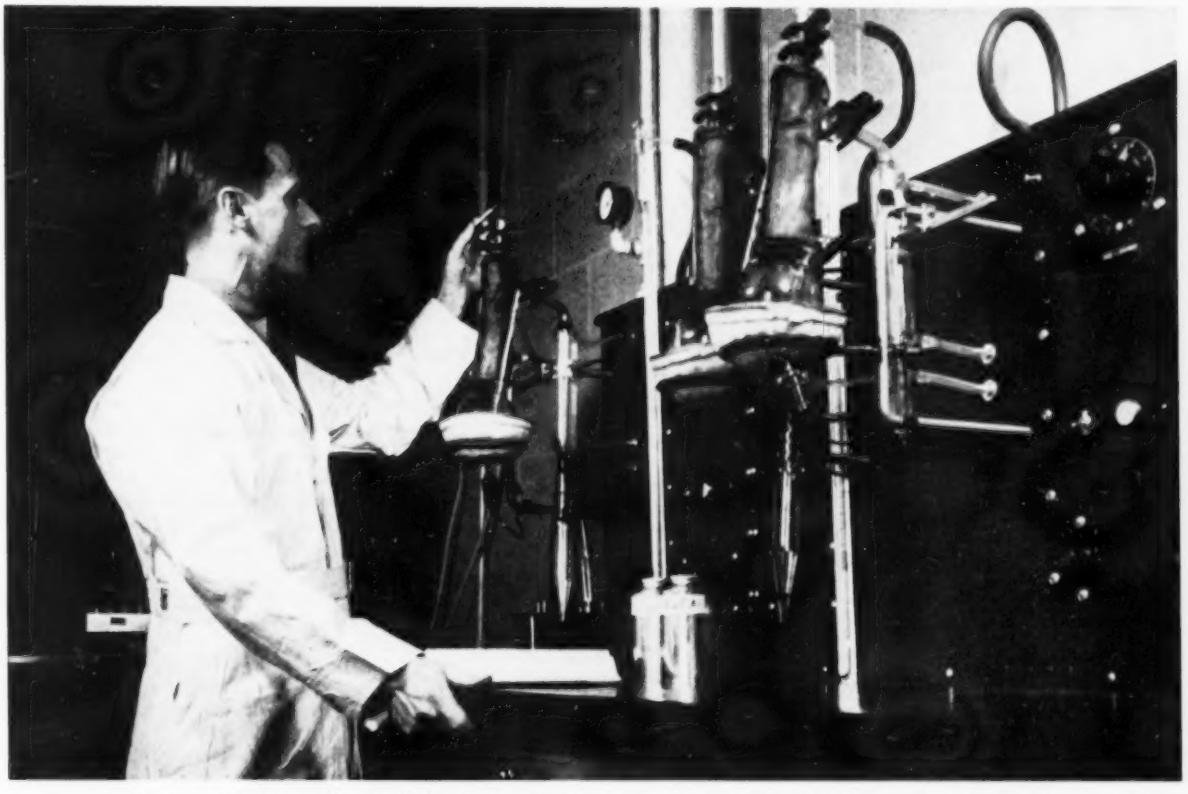

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Used Lube Oil Test every 20 Minutes

A RAPID system for analyzing used motor lubricating oils, requiring only about 20 minutes when the system is operating at full capacity, has been developed by Pure Oil Research & Development Laboratories at Crystal Lake, Ill.

The values obtained by the system include: viscosity, dilution, mineral oil content, oil oxidation products, fuel deterioration products, extraneous contaminants, water, and remaining detergency.

In addition to the high speed, the procedure does not require the highly skilled operator of conventional analytical methods. This is made possible by simplified methods and the use of automatic controls. Actually the original aim had been 24-hr. sample results.

Accuracy is in the range of ±5%, although the original precision goal had been ±10%. Extreme accuracy is not required in used oil testing since the oil is changing continually in properties anyway, and the interest is more generally in a trend than in absolute values. Results have been found comparable in significance to those obtained by ASTM methods for used oil tests.

Viscosity is determined by a torsion-type viscometer. With a 16-place turntable in a constant temperature bath for samples, one determination is completed every seven minutes.

In detail: the sample is preheated to test temperature (100°F.) in an oven upon receipt. It is then transferred to one of the 16 beakers in the oil bath. The viscometer consists of an electric motor-driven spindle equipped with a calibrated disk. A dial registers motor torque at synchronous speed, which can be converted to viscosity.

Total time required for filling the beakers, measuring torque, washing torque shaft between measurements, converting torque indications to viscosities, emptying beakers, and washing in preparation for the next test is about 110 minutes for 16 samples, or around seven minutes per sample.

Dilution of the oil by fuel is characterized by a marked decrease in viscosity. It is measured quantitatively by vacuum distillation. Both fuel dilution and water are measured. A battery of six vacuum stills operate pretty much automatically. Vacuum is applied and maintained, and heating of the flask occurs at a pre-determined rate, both under automatic control. Heating stops automatically at the temperature where previous tests have indicated that all raw fuel and water are evaporated. The relative quantities of each are observed in the trap. (See photograph.)

Percentage of solids is observed volumetrically after dilution with a special naphtha, and centrifuging. The first centrifuging determines "undispersed" solids. With detergent type oils, however, the dispersed solids cannot be separated by simple centrifug-

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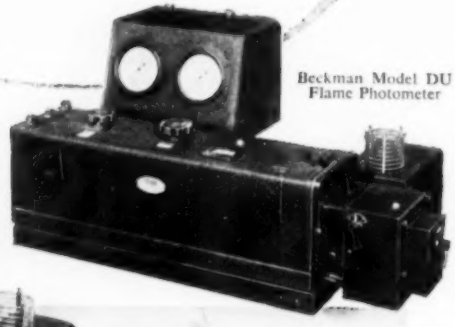

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ing. Therefore, following the first test the diluted sample is treated with a flocculating agent, and is whirled again.

All of the solids come down in the second test and are recorded as "total solids." By difference, the "dispersed" solids are approximated. This test has been found of value in estimating the effectiveness of the detergent and also the condition of the oil filter.

Following the determination of the total solids, the special naphtha diluent is decanted, and a second solvent is added. This solvent is more or less specific for high molecular weight decomposition products resulting from oil decomposition. That portion of solids which is dissolved by this solvent is recorded as "tar and asphaltic" material. A third solvent, more or less specific for lower molecular weight fuel decomposition products, is then added and the amount dissolved is recorded as "gum."

The remaining material—consisting of soot, carbon, lead compounds, dirt, metal particles, etc.—is listed as the "insolubles."

To determine the types of insolubles, they are removed from the tube and spread on a microscope slide, and examined under the microscope. This simple examination has ben surprisingly effective in detecting abnormal amounts of solid contaminants which, as indicated by subsequent examination of the engines, were beginning to cause damage.

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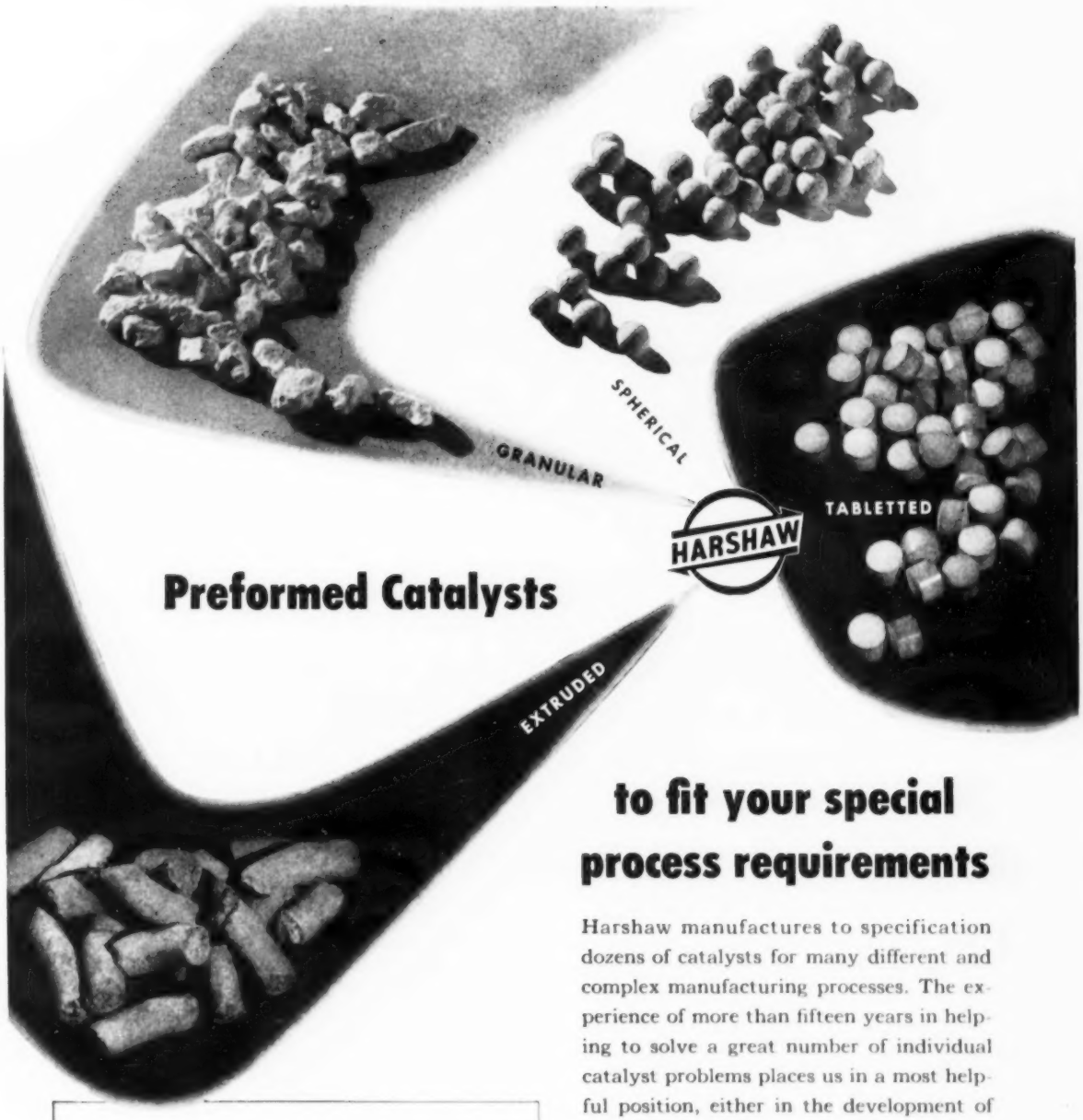

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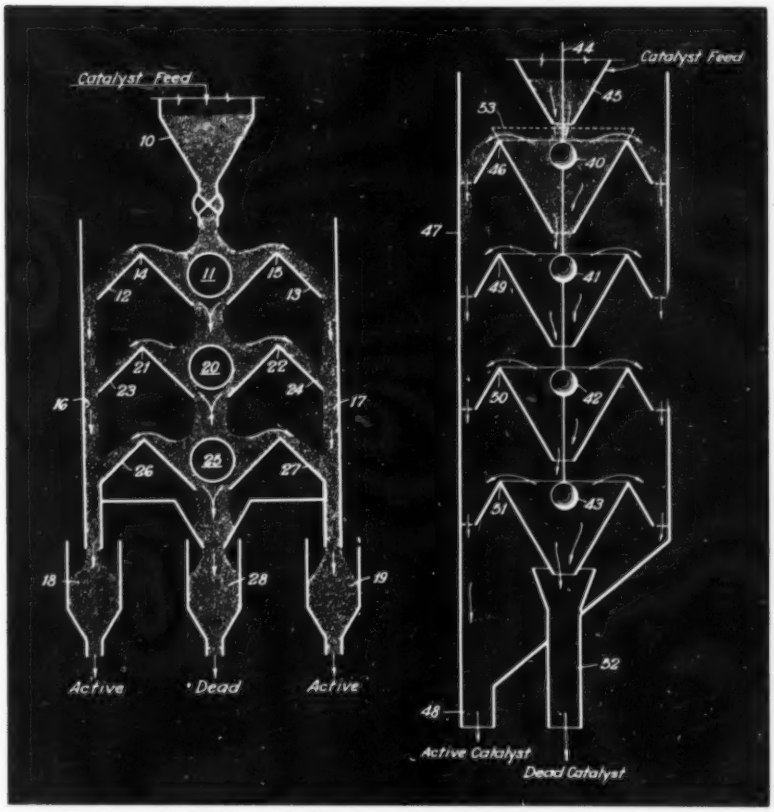

FIG. 1—Two types of electrokinetic separators; frustoconical design at the right

Separating Live from Dead Catalyst

IN the conversion of hydrocarbon oils with dispersed inorganic oxide catalysts, wherein the hydrocarbon is contacted at high temperature (950-1000° F.), it is common practice to regenerate the catalyst at frequent intervals by burning off the carbon deposits and return the catalyst to the reaction zone for further conversion.

In the fluid catalyst process using powdered catalyst, the reaction and regeneration are carried on continuously with circulation of catalyst between reaction and regeneration zones. After the catalyst has been in use for a considerable period of time (1000-5000 hrs.) involving hundreds of regenerations, the catalyst suffers a permanent loss of activity. Thus, where a new catalyst may have an activity of 100 IRA (Indiana Relative Activity), it may average only about 10-20 IRA after extensive use and periodic addition of fresh catalyst to make up for losses. It then becomes necessary to discard catalyst and add new catalyst to maintain desired conversion.

In U. S. Patent 2,635,749, Standard Oil Co. (Indiana) discloses that such "dead" catalyst still contains particles which have a relatively high activity. A separation step is proposed to reduce make-up catalyst and raise the activity level in the conversion unit.

The separation is based on the observation that live catalyst will migrate farther in an electrostatic field than dead catalyst, thereby enabling an electrokinetic separation to be effected. The process can be more readily understood by reference to Fig. 1 showing one type of electrokinetic separator (left) and a frustoconical design employing the same principle (right).

In these illustrations, normally discarded catalyst from the conversion unit is fed in a thin stream by hopper 10 or 45 onto electrode 11 or 40 which may be of rod or ball design (as shown). The catalyst particles are charged on contact with the electrode and are scattered upwardly and outwardly in the electrostatic field existing between electrode 11 (or 40) and surrounding electrodes 12-13 (or 53).

The more active catalyst particles receive a greater charge on contact with electrodes 11, etc. and migrate further in the electrostatic field, jumping ridges 14-15 (or 46) and then falling down through channels 16-17, leading to active catalyst containers 18-19 (or 48). Catalyst particles which fail to be carried over the ridges pass around the electrode 11 (or 40) and onto electrode 20 (or 41) where the operation is repeated and new charges are given the catatlyst particles. This process is repeated until the really dead catalyst particles end up in storage bin 28 (or 52).

Electrodes 11, 20, 25 (or 40, 41, 42, 43) are interconnected and separated from the surrounding electrodes by a gap which generally exceeds one-half inch for 20,000 volts, in order to avoid arcing between electrodes. Use of a constant unchanging potential is undesirable and results in bridging of the apparatus with charged catalyst particles which block the flow of catalyst from one electrode to another. It is preferred to use an alternating potential of 1-4 cps frequency.

One experiment recited, employed

Table I—Results of Electrokinetic Separation Experiments

Fraction	*Wt.-% on original*	*Carbon content*	*Activity estimated from carbon content*
First Pass:			
Feed	——	1.443	20
Dead	18.5	1.247	16
Active	81.5	1.488	21
Second Pass:			
Dead	6.3	0.888	11
Active	12.2	1.40	19
Third Pass:			
Dead	2.7	0.494	4
Active	3.6	1.210	16

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a voltage of 15,000 with inter-electrode distance of 1.43 cm. (bottom) to 2.38 cm. (top), and a field strength of 10,500 v/cm. (bottom) to 6,300 v/cm. (top), at a frequency per second of 2 and catalyst rate of 4 kg./hr. About 11.3 kg. of an unregenerated silica-alumina catalyst used in cracking gas oil were charged in the separator in three successive passes, with the results obtained being reported as given in Table 1.

It will be observed that the activity of the separated live catalyst after the third pass was four times that of the dead fraction. It is generally desirable (but not necessary) to grade the catalyst with respect to particle size before making the electrokinetic separation.

Patents Issued in July

The following classified listing gives the patent number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for July 7, 14, 21, and 28, 1953, Vol. 672, Nos. 1-4.

PROCESSES

Catalysts

2,644,798 (Standard Oil Development Co.) Hydroxylated aluminum halide polymerization catalyst.
2,644,800 (Standard Oil Development Co.) Shaped catalyst on metal support for packed catalytic reactor.
2,645,619 (Universal Oil Products Co.) Manufacture of silica sol.
2,645,620 (Lever Brothers Co.) Nickel-alumina-silica catalysts and their preparation.

Conversions

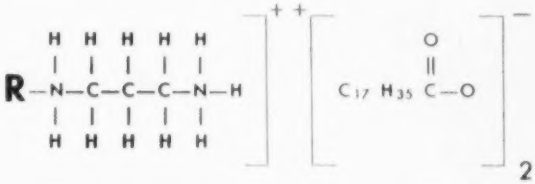
2,645,562 (Anglo-Iranian Oil Co. Ltd.) Production of a gaseous petroleum fraction rich in hydrogen by controlled cracking in presence of clay.
2,645,567 (Shell Development Co.) Catalytic reactor tube assembly.
2,645,604 (Phillips Petroleum Co.) Tandem-bed hydroforming process using chromia-alumina catalyst.
2,645,605 (Socony-Vacuum Oil Co.) Reforming and Cr catalysts therefor.
2,645,670 (Universal Oil Products Co.) Production of poly-alkylated aromatic hydrocarbons, using Pt catalyst on pinane.
2,645,672 (Phillips Petroleum Co.) Alkylation of aromatic hydrocarbons.
2,646,316 (Houdry Process Corp.) Solids lift disengager.
2,646,347 (Standard Oil Development Co.) Two-pass high-pressure reactor.
2,646,388 (Gulf Research & Development Co.) Hydrodesulfurization process using hydrogen and nickeliferous agent.
2,646,391 (Houdry Process Corp.) Method of and apparatus for converting hydrocarbons.
2,646,407 (Houdry Process Corp.) Art of handling fluent particles.
2,646,452 (Universal Oil Products Co.) Alkylation by modified aluminum halide catalyst.
2,646,453 (Phillips Petroleum Co.) Concentration and use of methylcyclopentane in 2,2,4-trimethylpentane isomerization.
2,647,041 (Phillips Petroleum Co.) Production of hydrogen from hydrocarbons by passing over hot pebbles of Fe, Ni, Cr or Cu.
2,647,042 (Houdry Process Corp.) Production of hydrogen-rich gases by thermal conversion of hydrocarbons with inert gas at 1200-1800°F.
2,647,045 (Roman Rummel) Gasification of combustible materials (coal).

New Armour chemical cuts corrosion costs of primary wells

Major petroleum companies find Duomeen® T Dioleate more effective than dilute inhibitors — and lower in cost!

The latest development of the Armour Chemical Division's petroleum chemists is Duomeen T Dioleate—a potent corrosion inhibitor for "Down the Hole" treatment of primary producing wells. The ability of this new cationic surface active agent to convert steel surfaces from water-wettable to oil-wettable, thus forming a protective film, is the reason for the excellent protection provided by Duomeen T Dioleate.

Manufactured under exacting laboratory specifications, Duomeen T Dioleate is supplied *100% active*—water insoluble but readily soluble in common solvents. Particularly outstanding results have been obtained in controlling acid conditions in sour wells. Laboratory and field tests report 20 ppm of this chemical sufficient to gain maximum effectiveness. While this amount is reported as being successful, it is realized that specific locations and conditions may exist where greater concentrations are necessary. However, since Duomeen T Dioleate is supplied 100% active, it provides great flexibility by permitting the user to meet such conditions by making up any desired solution at the site. Duomeen T Dioleate also has application in other hydrocarbon systems and product lines. For the benefit of engineers who wish to know the chemical structure of this new and unique product, the structural formula for Duomeen T Dioleate is as follows:



Samples and complete data are readily available. Simply fill in and mail the coupon with your letterhead for free samples and a copy of our "Combat Corrosion" bulletin and Technical Bulletin E-6, "Chemical Treatment in Oil Wells."

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City ..... *Zone* ..... *State* .....

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ARMOUR CHEMICAL DIVISION

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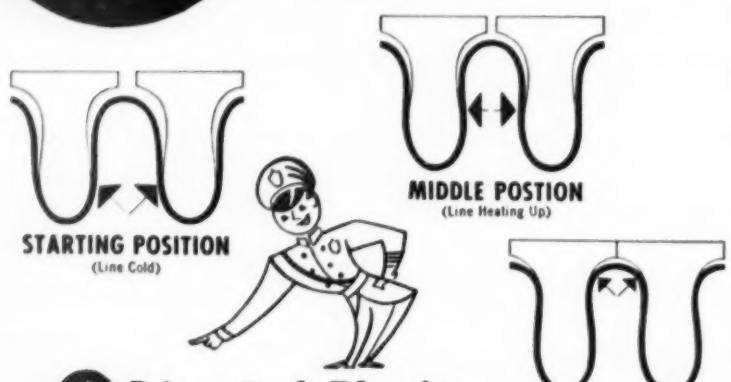
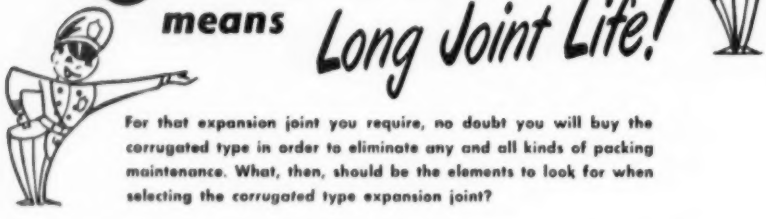
Badger EXPANSION JOINTS



1 Directed Flexing means *Protected* Corrugation

2 Protected Corrugation means *Long Joint Life!*



For that expansion joint you require, no doubt you will buy the corrugated type in order to eliminate any and all kinds of packing maintenance. What, then, should be the elements to look for when selecting the *corrugated* type expansion joint?

Look into the shape and depth of the corrugation. Look into the shape and size of the matching equalizing rings. Corrugations and rings serve a purpose. The question is, "How well do they serve it?"

In the Badger Expansion Joint —the design of the corrugation is such as to 'direct' the flexing of the all-curve element along the surface of matching all-curve rings. The depth of corrugation is deliberately correlated to the joint diameter and anticipated traverse. The result is that flexing stresses are distributed and that no corrugation or segment of a corrugation takes more of the traverse than it should . . . all of which make the Badger Directed-Flexing Self-Equalizing Expansion Joint the superior joint.

Badger Directed-Flexing Self-Equalizing Joints come standard in a wide range of diameters, with flanged or welding ends, in special deoxidized copper and stainless steel. Special joint designs available for special problems.

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET • CAMBRIDGE • MASS.

2,647,075 (Anglo-Iranian Oil Co. Ltd.) Catalytic cracking of hydrodesulfurized petroleum hydrocarbons with a clay treated catalyst.
2,647,076 (Anglo-Iranian Oil Co. Ltd.) Catalytic cracking of sulfur containing petroleum hydrocarbons with a clay treated catalyst at temperature related to Fe_2O_3 content of clay.
2,647,077 (Phillips Petroleum Co.) Process for destructive distillation of oil shale.

Hydrocarbon Synthesis

2,644,745 (Standard Oil Development Co.) Production of gases containing CO from carbonaceous solids.
2,644,786 (Standard Oil Development Co.) Precipitation of nonvolatile substances in distillation of Fischer-Tropsch synthesis mixtures.
2,644,829 (Phillips Petroleum Co.) Preconditioning hydrocarbon synthesis catalyst.
2,646,442 (The Texas Co.) Hydrocarbon synthesis.
2,647,138 (Ruhrchemie Aktiengesellschaft) Fe catalyst for the hydrogenation of carbon monoxide.
2,647,139 (M. W. Kellogg Co.) Separation of organic compounds.
2,647,149 (California Research Corp.) Production of oxygen-containing carbon compounds.

Refining

2,644,797 (California Research Corp.) Gasification of sulfuric acid wastes.
2,644,799 (Phillips Petroleum Co.) Heat-exchange pebbles having resistance to abrasion and shock.
2,645,104 (The Lummus Co.) Fractional distillation of C_4C_5 hydrocarbons.
2,645,463 (Standard Oil Development Co.) Method and apparatus for continuous flow mixing.
2,645,467 (Standard Oil Development Co.) Leaning bubble tower.
2,645,565 (Standard Oil Development Co.) Liquid-liquid extraction tower.
2,645,596 (Phillips Petroleum Co.) Extraction of light lubricating oils with a phenol-alkanolamine solvent.
2,645,597-600 (Socony-Vacuum Oil Co.) Process for separating wax from wax-oil mixtures.
2,645,601 (Phillips Petroleum Co.) Treatment of paraffins with aluminum bromide to reduce pour point.
2,645,602 (Standard Oil Co.-Ind.) Sweetening hydrocarbon distillates with KOH and oxygen.
2,645,603 (Socony-Vacuum Oil Co.) Inhibiting oxidation of mercaptans to polysulfides with N, N'-di(sec. butyl) phenylene diamine, extracting with alkali in absence of air.
2,645,608 (Standard Oil Development Co.) Sulfur dioxide extraction process.
2,645,652 (Standard Oil Development Co.) Fractionation of oleiferous materials with ketone solvent.
2,646,266 (C. F. Braun & Co.) Multiple flow column.
2,646,387 (Socony-Vacuum Oil Co.) Solvent recovery with liquid carbon dioxide.
2,646,389 (Standard Oil Co.—Ind.) Sweetening hydrocarbon distillates with KOH, copper catalyst and oxygen.
2,646,390 (Standard Oil Co.—Ind.) Desulfurization of distillate fuels with $AlCl_3$ and liquid SO_2.
2,646,392 (Universal Oil Products Co.) Apparatus for fractionating multicomponent streams.
2,646,404 (Cities Service Research Development Co.) Process for breaking petroleum water-in-oil emulsions.
2,646,405 (Cities Service Oil Co.) Surface active compounds for breaking emulsions.
2,646,406 (Cities Service Oil Co.) Surface active compounds for resolving emulsions.
2,646,451 (Sun Oil Co.) Continuous adsorption process.

PRODUCTS

Chemicals

2,644,769 (Phillips Petroleum Co.) Coating of ammonium nitrate fertilizer.
2,644,804 (M. W. Kellogg Co.) Packing composition containing polytrifluorochloroethylene and an inorganic antifriction agent.
2,644,807 (Universal Oil Products Co.) Polyvinyl acetal resins.
2,644,809 (Standard Oil Development Co.) Friedel-Crafts isobutylene polymerizations in chlorofluoroalkane solution.
2,644,810 (Standard Oil Co.—Ind.) Method of sulfurizing esters.
2,644,811 (Standard Oil Co.—Ind.) Sulfurization of oxygenated aliphatic compounds.
2,644,825 (Standard Oil Co.—Ind.) Method of sulfurizing fats and fatty acids.
2,644,826 (Tide Water Associated Oil Co.) Dinitrogen containing di-carboxylic acids.
2,644,834 (Shell Development Co.) Process for the production of nitriles.
2,644,837 (E. I. du Pont de Nemours & Co.)

The Greatest Gasoline Development in 31 Years

TCP*, a Shell discovered additive now blended into Shell Premium Gasoline, sets the pace for the fuels of tomorrow. It's another milestone in Shell's petroleum research.

The long-recognized problem of power loss due to combustion by-products has been solved by Shell research. No longer need these by-products cause the waste of fuel and power associated with missing spark plugs and with pre-ignition.

Shell research has discovered and developed a fuel additive now in Shell Premium Gasoline—called TCP. This additive actually changes the character of harmful deposits *within the engine* so that faulty spark plug operation and pre-ignition are eliminated promptly—often during the second tankful. Old *and* new engines benefit alike.

Shell TCP additive was originally developed for aviation fuels. Up until now it has been restricted to military planes. Without question it is the greatest fuel development since the introduction of tetraethyl lead in 1922.

Important as TCP additive is for cars today, perhaps the greatest significance is its great promise for the future. TCP additive points the way to lighter, more powerful engines—engines with much greater design efficiency than has heretofore been possible.

TCP is Shell's trademark for this additive. It is another example of the progressive research that goes forward day and night in Shell laboratories. It is evidence again that Shell research provides more and better products from petroleum.

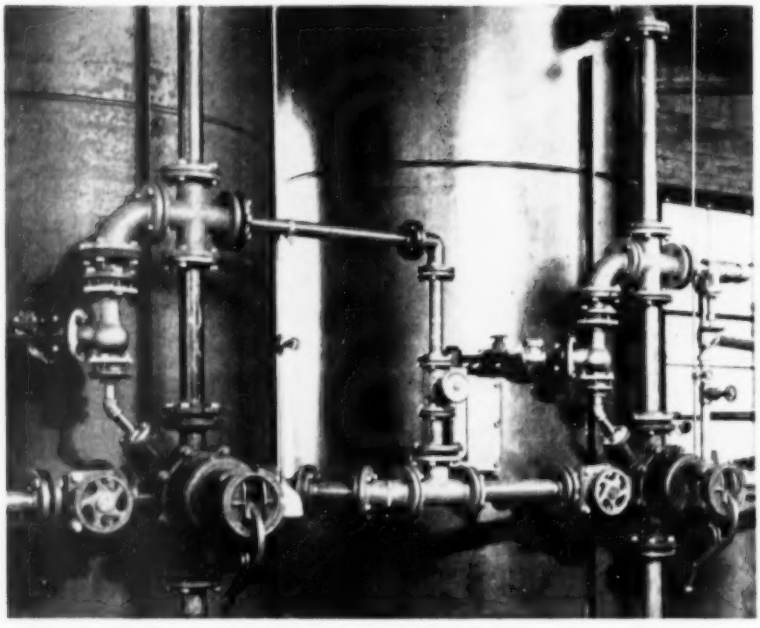
*Patent applied for

SHELL OIL COMPANY

SHELL

CUT CORROSION COSTS

install corrosion-resistant SARAN LINED STEEL PIPE for long, trouble-free service



Saran Lined Pipe, Fittings and Valves are used in this automatic water deionizer in a large water purification system. Installations such as this give trouble-free service for many years.

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Please send me a copy of your catalog on Saran Lined Pipe, Valves and Fittings.

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Corrosion-resistant Saran Lined Steel Pipe sharply reduces repair and maintenance costs in corrosive piping installations. Downtime is cut to a minimum because this rigid pipe has high pressure strength and durability—which mean dependable, long-term service. Easily installed Saran Lined Steel Pipe can be cut and threaded in the field—no need for special tools or handling. Wherever superior resistance to most chemicals and solvents is demanded, be sure to consider Saran Lined Pipe, Fittings and Valves. Write to the distributor: SARAN LINED PIPE COMPANY, 2415 Burdette Avenue, Ferndale, Michigan. Offices in: New York • Boston Pittsburgh • Tulsa • Philadelphia Chicago • Portland • Indianapolis San Francisco • Houston • Denver Los Angeles • Seattle • Cleveland Charleston, S. C. • Toronto • Montreal. Clip and send today!

SARAN LINED PIPE COMPANY
2415 BURDETTE AVENUE, FERNDALE, MICHIGAN

Patents

Oxidation of olefinic compounds to produce polyhydroxy products.
2,644,840 (Monsanto Chemicals Ltd.) Oxidation of hydrocarbons.
2,644,844 (E. I. du Pont de Nemours & Co.) Process of preparing primary branched heptadecyl alcohol from CO, hydrogen and tetraisobutylene.
2,644,846 (Shell Development Co.) Hydrogen chloride oxidation.
2,644,847 (Universal Oil Products Co.) Process and product of producing hydrocarbon drying oils from conjunct polymerization sludge.
2,645,631 (Phillips Petroleum Co.) Emulsion copolymerization of sulfur dioxide and unsaturated organic compounds.
2,645,649 (Universal Oil Products Co.) Process for improving the drying qualities of hydrocarbon polymer drying oils.
2,645,655 (Stanolind Oil and Gas Co.) Recovery and purification of oil soluble oxygenated compounds.
2,645,656 (Anglo-Iranian Oil Co. Ltd.) Production of surface active sulfates by reaction with hydroperoxide.
2,645,657 (Standard Oil Development Co.) Thionosphate esters.
2,645,659 (Shell Development Co.) Sulfur-containing ethers of polyhydric alcohols and derivatives thereof.
2,645,660 (Standard Oil Development Co.) Excess acid process for the manufacture of esters.
2,645,665 (Cities Service Oil Co.) Formaldehyde purification process.
2,645,667 (Phillips Petroleum Co.) Condensation of alcohols in the presence of calcium hydroxide.
2,645,668 (Phillips Petroleum Co.) Condensation of alcohols in the presence of calcium oxide.
2,645,669 (Universal Oil Products Co.) Hydrogen transfer process to produce pure individual hydrocarbon.
2,645,671 (Standard Oil Co.—Ind.) Stilbene from benzyl mercaptan.
2,647,109 (Phillips Petroleum Co.) Emulsion polymerization in the presence of an improved reducing composition.
2,647,143 (Stauffer Chemical Co.) Manufacture of perchloromethyl mercaptan.
2,647,150 (Pure Oil Co.) Separation of alcohols from mercaptans.
2,647,151 (Pure Oil Co.) Production of methanethiol.

Fuels

2,645,079 (Union Oil Company of Calif.) Method of operating jet propulsion motors with low m.w. nitrates or nitrates.
2,645,568 (Socony-Vacuum Oil Co.) Jet fuel containing t-butyl thiophene.
2,645,569 (Socony-Vacuum Oil Co.) Jet combustion fuel containing thiophene tar, etc.
2,645,906 (Phillips Petroleum Co.) Liquefied petroleum gas fuel system.
2,645,907 (National Cylinder Gas Co.) Apparatus and method for filling containers with predetermined quantities of gas.
2,646,348 (Standard Oil Development Co.) Gasoline fuels containing dimethyl carbinol and solvent oil.
2,646,784 (John E. McKeever) Apparatus for extracting oil vapors from crankcases for use as fuel.
2,647,046 (Socony-Vacuum Oil Co.) Jet combustion fuel (hydrocarbon distillate containing thiophene tar).

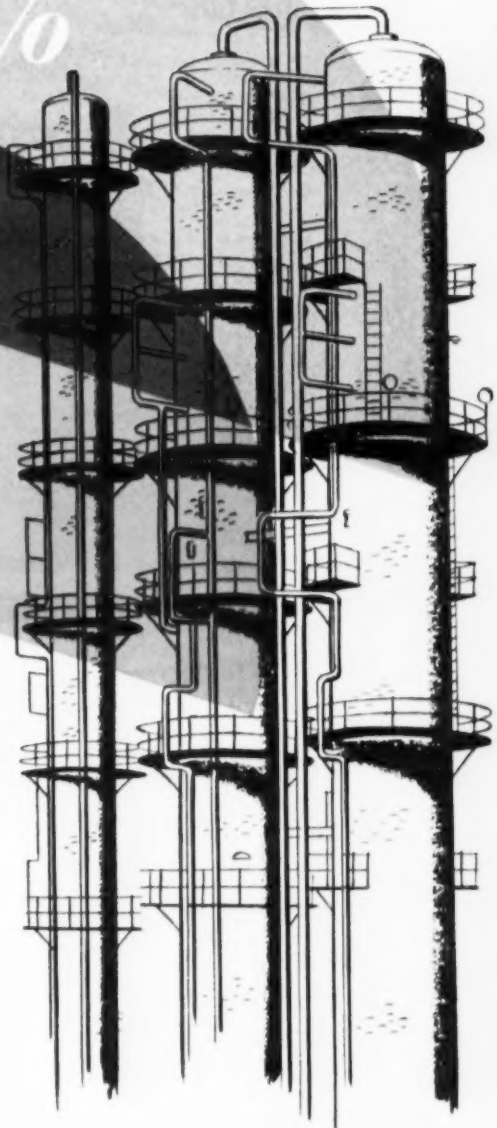
Lubricants

2,644,792 (Standard Oil Development Co.) Compounded lubricating oil containing P.S compound as detergent.
2,644,794-5 (Monsanto Chemical Co.) Hydrocarbon oil compositions containing polymer foam inhibitors.
2,644,802 (E. I. du Pont de Nemours & Co.) Tetrafluoroethylene polymer compositions containing polyorganosiloxane lubricants.
2,645,613 (Shell Development Co.) E.P. lubricating composition containing phosphite, arsenite or antimonite.
2,645,614 (Tap and Drill Ez Corp.) Metal-working lubricant.
2,646,401 (Standard Oil Development Co.) Fibrous Li lubricating grease.
2,646,402 (The Texas Co.) Manufacture of zinc salts of high molecular weight alkylated hydroxy aromatic compounds.

Specialties

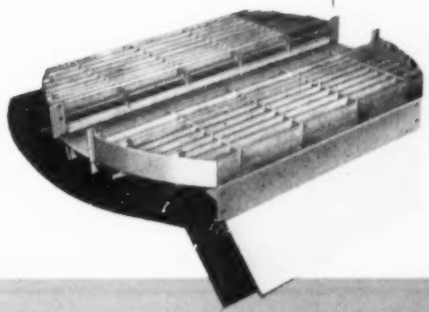
2,644,793 (Standard Oil Development Co.) Rust inhibiting composition containing thio acid.
2,646,349 (Sinclair Refining Co.) Light distillate compositions containing sulfurized tall oil.
2,646,350 (Golden Bear Oil Co.) Petroleum herbicide emulsions containing resinous petroleum fraction.
2,646,361 (Golden Bear Oil Co.) Dust-laying emulsion containing resinous petroleum fraction.
2,646,362 (Gulf Research & Development Co.)

You can save 30% to 50% of your tower costs



Design Factors	Bubble Trays	"Benturi" Kaskades
Low vapor thruput	+	−
High vapor thruput	−	+
Low liquid thruput	+	−
High liquid thruput	−	+
Low pressure drop	−	+
High pressure drop	+	−
High pressure towers	−	+
Low pressure towers	+	+
Alloy or alloy-clad towers	−	++
Shop fabricated towers	−	+
Field fabricated towers	−	++

Check your requirements on this simple chart. While any one of the "plus" features justify the economy of Koch "Benturi" Kaskade trays, a combination of these conditions provides a "bonanza" to the operator. We'll be glad to give you data on "Benturi" installations to fit your requirements. No obligation.



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British Associates
Messrs. A. P. Craig & Co., Ltd.
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Hooker Chemical Guide
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USE this handy reference to save time in selecting high-quality chemicals.

HOOKER SOLVENTS

MONOCHLOROBENZENE

Synonym: Phenyl Chloride
Formula: C_6H_5Cl
Molecular Weight: 112.5
Appearance: Clear, colorless liquid

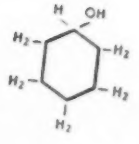
TYPICAL PROPERTIES

Freezing Point	−44° C
Distillation Range	131.2° to 132.2° C
Specific Gravity, 15.5°/15.5° C	1.114

USES

INSECTICIDAL INTERMEDIATE: DDT and other insecticides.
DYESTUFF INTERMEDIATE: Sulfur black and brown dyes.
CHEMICAL INTERMEDIATE: Organic synthesis.
SOLVENT: Paints, varnishes, lacquers, paint removers; general use.
HEAT TRANSFER FLUID: Suggested for condensing vapor systems, such as glass-enameled vessel jackets, which cannot stand high steam pressures.

CYCLOHEXANOL



Synonym: Hexahydrophenol
Formula: $C_6H_{11}OH$
Molecular Weight: 100.1
Appearance: Viscous, colorless liquid with pleasant, aromatic odor.

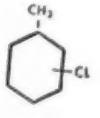
TYPICAL PROPERTIES

	High Grade	Tech. Grade
Freezing Range	18° to 22° C	−10° C to −20° C
Boiling Point	161.7° C	161.7° C
Specific Gravity, 25°/15.5° C	0.945	0.939
Flash Point	67° C	61° C

USES

SOLVENT: For resins, metallic soaps, dyes, fats and oils.
BLENDING AND STABILIZING AGENT: In textile soaps and dry cleaning agents.
HOMOGENIZING AGENT: For lacquers, varnishes and paints.
ALSO USED: In furniture and metal polishes, shoe creams, floor waxes, degreasing of leather, lubricating oils, also a plasticizer and ingredient of adhesives, and as a chemical intermediate in organic synthesis.

MONOCHLOROTOLUENE



Synonym: Methylchlorobenzene
Formula: $CH_3C_6H_4Cl$
Molecular Weight: 126.5
Appearance: Clear, colorless to straw-colored liquid.

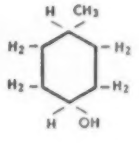
TYPICAL PROPERTIES

Freezing Point	below −45° C
Distillation Range	158.3° to 161.7° C
Specific Gravity, 15.5°/15.5° C	1.080

USES

SOLVENT: Rubber and synthetic resins.
INTERMEDIATE: Manufacture of rubber accelerators, chemicals.

METHYL CYCLOHEXANOL



Synonym: Hexahydrocresol
Formula: $CH_3C_6H_{10}OH$
Molecular Weight: 114.1
Appearance: Light straw-colored, neutral, viscous liquid.

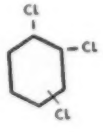
TYPICAL PROPERTIES

Distillation Range	155° to 180° C
Specific Gravity, 15.5°/15.5° C	0.924
Flash and Fire Points	71° C

USES

SOLVENT: For cellulose acetate, nitrocellulose and other cellulose esters for lacquers and coating compositions.
ANTI-OXIDANT: In lubricants.
BLENDING AGENT: For special textile soaps and detergents.

TRICHLOROBENZENE, Tech.



Formula: $C_6H_3Cl_3$
Molecular Weight: 181.5
Appearance: Clear, almost colorless liquid

TYPICAL PROPERTIES

Freezing Point	10° C
Distillation Range	5° incl. 216° C
Specific Gravity, 15.5°/15.5° C	1.466

USES

INSECTICIDE: Soil poison for termites.
SOLVENT: Fats, oils, waxes, resins; crystallization solvent.
HEAT TRANSFER MEDIUM: Condensing vapor systems, 210° to 300° C.
DIELECTRIC FLUID: Transformers.
INTERMEDIATE: Dye intermediates, other organic chemicals.

• *For more information on items listed,* drop a note on your letterhead to:

HOOKER ELECTROCHEMICAL COMPANY
4713 Buffalo Avenue, Niagara Falls, N.Y.

HOOKER ELECTROCHEMICAL COMPANY

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HOOKER® CHEMICALS

2-1520

(*To obtain more data on advertised products see page* 1400)

Paraffin wax compositions containing hydroquinone monobenzyl ether inhibitor.

2,646,363 (Robert R. Parmentier) Sealing composition for transparentized paper (containing gasoline fraction).

2,646,399 (Cities Service Research and Development Co.) Method of inhibiting corrosion of metals, using dibasic acid reacted with polyethylene amine.

2,646,400 (Cities Service Research and Development Co.) Method of inhibiting corrosion of metals with polyethylene amine.

EQUIPMENT

Processing, general

2,644,645 (L. Sonneborn Sons, Inc.) Wax winding and slabbing device.

2,644,744 (Universal Oil Products Co.) Reactor for high temperature cracking.

2,644,785 (Standard Oil Development Co.) Combination crude still and cracking process and apparatus.

2,645,103 (A. J. and I. F. Fausek) Apparatus for separating the constituents of gaseous mixtures.

2,645,350 (Ingeniorsfirman Fliesberg Aktiebolag, Stockholm, Sweden) Flotation apparatus for separating particles suspended in a liquid.

2,645,415 (De Laval Separator Co.) Centrifugal bowl.

2,645,462 (The Air Preheater Corp.) Plate type heat exchanger.

2,645,462 (Standard Oil Development Co.) Apparatus and method for continuous flow mixing.

2,645,467 (Standard Oil Development Co.) Tilted, or leaning, fractionating tower.

2,645,468 (Gilbert & Barker Mfg. Co.) Bubble cap assembly.

2,645,469 (Gilbert & Barker Mfg. Co.) Bubble cap fastening means.

2,645,565 (Standard Oil Development Co.) Liquid-liquid extraction tower.

2,645,566 (Gas Machinery Co.) High temperature reactor.

2,645,609 (Holford Processes Ltd., London; and George Adlam & Sons Ltd., Bristol, England) Vertical oil-shale retort.

2,646,132 (Research Corp.) Electrical precipitator for gas separation.

2,646,133 (Stone & Webster Engrg. Corp) Apparatus and method for separating a liquefiable component from a gaseous material.

2,646,172 (Baker Perkins, Inc.) Centrifugal separator.

2,646,266 (C. F. Braun & Co.) Multiple flow fractionating column.

2,646,347 (Standard Oil Development Co.) Two-pass, uni-directional flow, high pressure reactor.

2,646,392 (Universal Oil Products Co.) Fractionating column for multicomponent streams.

2,646,971 (Walter Raskin) Heat exchange unit.

2,646,977 (The Lummus Co.) Vapor liquid contact tower.

Catalytic Reactors

2,644,800 (Standard Oil Development Co.) Shaped catalyst for packed catalytic reactor.

2,645,567 (Shell Development Co.) Catalytic reactor tube assembly.

2,646,316 (Houdry Process Corp.) Lift disengager for granular particles.

2,646,391 (Houdry Process Corp.) Catalytic conversion apparatus and process.

2,647,044 (Houdry Process Corp.) Solids baffle for catalyst apparatus.

Instruments

2,644,328 (Phillips Petroleum Co.) Device for testing pebble strength.

2,644,329 (U.S.A. as represented by Secretary of the Navy) Fluid density meter.

2,644,442 (Republic flow Meters Co.) Combustion control system for a steam boiler.

2,645,061 (Combustion Engrg. Inc.) Pressure regulator and cutoff with auxiliary manual control.

2,645,062 (Air Reduction Co.) Gas pressure regulator.

2,645,124 (Air Reduction Co.) Flowmeter for gases.

2,645,125 (Alfred A. Miller) Liquid level indicator.

2,645,126 (Bailey Meter Co.) Temperature measuring bolometer.

2,645,248 (Cook Electric Co.) Differential pressure actuation device.

2,645,278 (Harry B. Holthouse) Ignition system and means for initiating combustion of fuel in a fuel burner.

2,645,289 (Standard Oil Development Co.) Displacement type sampler.

2,645,461 (Socony-Vacuum Oil Co., Inc.) Temperature regulator.

2,645,552 (National Research Council, Ottawa, Ont.) Trace identifier for optical oscillographs.

2,645,554 (Carter Tiffany) Thermo-responsive gas detector.

OFTEN THERE IS NO SUBSTITUTE FOR A GOOD LOOK

That's Why Industry Needs the "UTILISCOPE"

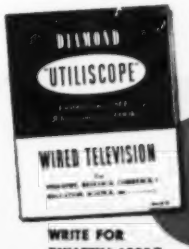
DIAMOND "UTILISCOPE"
(WIRED TELEVISION)

A description may help find a suspect, but before identification can be positive enough to stand in court, somebody who knows the man must take a good look at him.

In many industrial processes, there also is no substitute for a good look. Correct control depends upon the operator having a SENSE OF REALISM that instruments cannot provide . . . that SEEING alone can give.

The Diamond "Utiliscope" (wired television) enables the operator to have a "good look" at all times no matter how remote, inaccessible or dangerous the location of the process. The "Utiliscope" is exceptionally rugged, reliable, and moderate in cost. There undoubtedly are places in your plant where it will save money, improve quality, promote safety and/or reduce manpower requirements. Write for Bulletin.

TYPICAL USES—Studying destructive tests of engines • Watching flow of molten steel • Checking remote gauge readings • Observing conditions inside furnaces • Viewing nuclear research • Coordinating materials flow on conveyors • The "Utiliscope" (Registered U. S. Patent Office)



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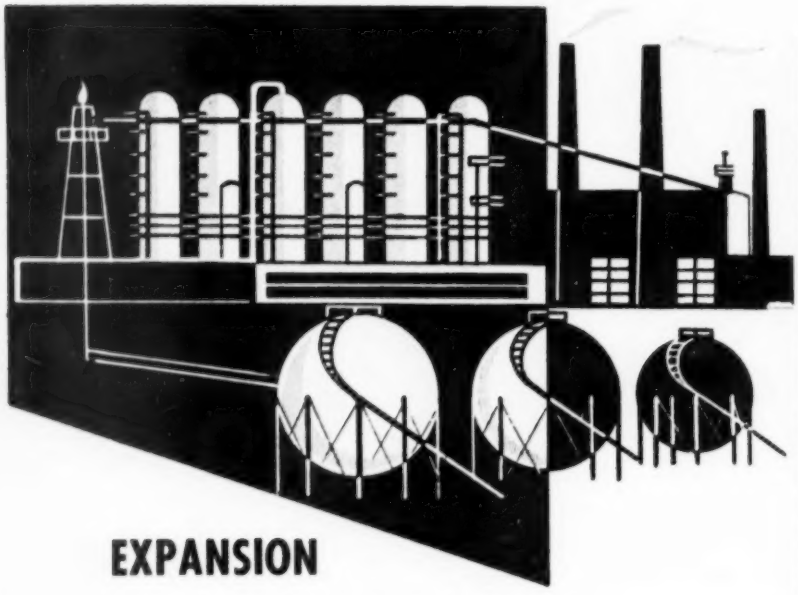

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PROCESS SYSTEMS & INSTRUMENTATION
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Patents

2,645,747 (The Texas Co.) Servo-mechanism hunt suppressor.
2,645,932 (Standard Oil Co.—Indiana) Apparatus for testing plastic flow.
2,645,949 (Phillips Petroleum Co.) Pressure balance indicator.
2,646,681 (Shell Development Co.) Automatic temperature indicating system.
2,646,683 (Hugo H. Pickron) Vacuum and pressure indicator.
2,646,778 (M. S. Bowne) Valve actuating control system.
2,647,083 (Roy B. Everson) Means for direct feed automatically proportioning of chlorine gas.

Pumps & Compressors

2,644,403 (Ingersoll-Rand Co.) Device for preventing clogging in centrifugal pumps.
2,646,001 (General Controls Co.) Circulating centrifugal pump structure.
2,646,207 and 2,646,208 (Arthur C. Layton) Centrifugal fluid compressor.
2,646,209 (J. A. N. Galliot, Bexley, England) Gas turbine driven multistage compressor.
2,646,210 (J. Eberspacher, Esslingen (Neckar), Germany) Turbocompressor.
2,646,212 (E. P. Kellie) Oil level equalizing device for multiple compressor arrangement.
2,646,756 (G. H. Peguet and Andre Guyennon, Montpellier, France) Rotary machine adapted to operate as a pump, compressor, or motor.
2,646,919 (Joy Mfg. Co. Compressor control system.

Valves & Fittings

2,645,239 (C. H. Horn and S. H. Smith) Emergency shutoff valve.
2,645,243 (L. D. Turner) Relief valve manifold.
2,645,244 (A. F. Klickman) Line blind.
2,645,401 (Food Machinery & Chemical Corp.) Container filling valve with head space providing means.
2,645,506 (Socony-Vacuum Oil Co., Inc.) Pipe flange connection.
2,646,063 (S. A. Hayes) Back flow preventer.
2,646,064 (D. G. Griswold) Valve apparatus for protecting fluid in one of two interconnected conduits from contamination with fluid in the other conduit.
2,646,065 (Standard Oil Development Co.) Valve for maintaining finely divided solids in a zone at substantially elevated pressures.
2,646,066 (Alex. Friedmann, Kommandit-Gesellschaft, Vienna, Austria) One-way valve, particularly for lubricating systems.
2,646,074 (R-S Products Co.) Variable stroke cushioned valve.
2,646,075 (James E. Elkington) Fluid-actuated, snap-acting gate valve.
2,646,245 (Pirelli Societa per Azioni, Milan, Italy) High pressure fluid control valve.
2,646,247 (L. S. Hamer, P. A. Dewhirst) Sealing construction for plug valves.
2,646,767 (John Hanson, Three Hills, Alberta) Valve position indicator.
2,646,816 (D. G. Griswold) Backflow prevention device.
2,646,817 (Sheffield Instrument Co.) Automatic shutoff for tank filling.
2,646,819 (Cherry-Burrell Corp.) Float controlled valve.
2,646,822 (Presstite Engrg. Co.) Plastic coated pipe and pipe fitting.
2,646,959 (Fred S. Carver, Inc.) High pressure fluid control valve.
2,646,996 (Chiksan Co.) Pipe union.
2,646,997 (Crane Co.) Flanged pipe joint.

Miscellaneous

2,644,612 (Standard Oil Development Co.) Safety device for oil storage tank.
2,644,675 (American Locomotive Co.) Heat exchanger.
2,645,507 (Chicago Rawhide Mfg. Co.) Self-contained oil seal.
2,645,508 (Crane Packing Co.) Rotary mechanical seal.
2,646,999 (Filton Ltd., Leamington Spa, Warwickshire, England) Fluid seal.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25¢ each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.

Safety Honors to Indiana Standard

Father-son team, representing 8200 employes of the Whiting, Ind., refinery, Standard Oil Co. (Indiana), and A. F. Endres, refinery manager, accept Award of Honor from National Safety Council president Ned H. Dearborn (right). Wearing safety hats, Robert W. Springer (left), new employe, and his father, John, a 20-year veteran, show workers' interest in continuing the company's 35-year safety improvement record.

Dr. William R. Veazey, recently retired Dow Chemical Co. director and research consultant, will have a new Texas Division research center dedicated in his honor in October.

The center, under construction at Freeport, Texas, for the past year, will house the division's organic, chemical engineering and electrochemical research as well as the analytical laboratory.

Dr. Veazey was with Dow since 1915, and for many years was also an assistant professor at Case Institute of Technology.

* * *

William A. Shine and **P. Wenzell, Jr.,** have joined the development department of Celanese Corp. of America. The department was recently established with **E. T. Powers** as director to study new technological advancements here and abroad.

For the last three years, Mr. Shine was director of marketing development for Arnold, Hoffman & Co. Mr. Wenzell has been with the Bureau of Mines, where for the past four years he was working on synthetic fuels.

* * *

F. S. Wood is now section leader in the automotive division at Standard Oil Co.'s (Ind.) Whiting, Ind. research laboratories. **C. C. Colyer** and **W. R. Shimmin** have been appointed group leaders in the same division.

Mr. Wood, who joined Standard in 1944 as an automotive engineer, is a graduate of the University of Virginia. Mr. Colyer, a Carnegie Institute of Technology graduate, and Mr. Shimmin, who holds a master's degree from Yale, came to the company more recently. All three men are members of the Society of Automotive Engineers.

* * *

J. R. Lane, Jr., superintendent of Dow Chemical Co.'s glycol plant at Freeport, has left his Texas Division post to take an assignment in the technical service and development department at Dow's Midland, Mich., plant. In his new job, Lane will serve the heavy industries section of the department. He will be responsible for conducting a long range program for the development of new Dow products used in the field of internal combustion engines.

Lane started with Dow in November, 1945, as a chemist in the ethylene glycol department. A chemical engineering graduate of Texas A and M College, he came to Dow at the completion of four years active duty in the Army.

* * *

H. C. Packard, Shell Oil Co., has been appointed chairman of a newly-formed American Petroleum Institute committee to develop a symposium on measuring, sampling and testing of crude oil and petroleum products.

A. H. Newberg, Service Pipe Line Co., Tulsa, is vice chairman, and **E. O. Mattocks** is secretary. For further details on the first meeting of this committee, see "Meetings," page 1393.

* * *

John Wylie has been appointed director of industrial relations at Pan-Am Southern Corp.'s El Dorado refinery, replacing **James L. Ward** who resigned to become an industrial relations consultant.

Before his new appointment, Mr. Wylie was assistant to T. G. Hanlon, manager of the firm's industrial relations department. Before joining Pan-Am early in 1951, Mr. Wylie was associated with the industrial relations department of the Deep Rock Oil Corp. in Tulsa, Okla.

Robert E. Mackey, who has served as personnel assistant at the El Dorado refinery for Pan-Am, will move to New Orleans to fill the post vacated by Mr. Wylie.

* * *

Paul Stefanik, formerly chief engineer of the chemical products group in Socony-Vacuum Oil Co.'s lubricating department, has been transferred to the lubricating and allied products staff of the company's foreign trade department. **Warren A. Beman,** until now head of chemical development and by-product activities in the same group, succeeds Mr. Stefanik.

* * *

I. B. Wilson has been named manager of Shell Oil Co.'s refinery shipping department at Martinez, Calif. Mr. Wilson was recently released as a major from duty as operations director of the 13th Air Force.

* * *

John M. Olin, president of Olin Industries, Inc., is now president of the newly-formed Matholin Corp., which will operate the first commercial-scale hydrazine plant in the U. S. The plant was recently built by Mathieson Chemical Corp. at Lake Charles, La., and is jointly owned by Olin and Mathieson.

Mr. Olin

Mr. Olin is one of the pioneer American researchers in hydrazine, having worked on its synthesis since 1912, some 30 before the Germans first used the compound as a rocket propellant. While engaged in

10 *water-treatment processes* in 1 *system*

- *Softening*
- *Heating*
- *Deaeration*
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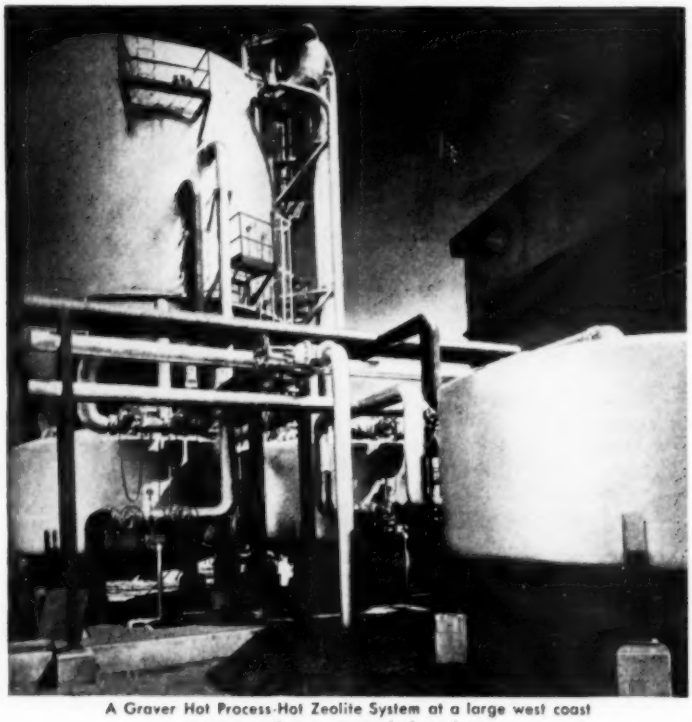
- *Dissolved Solids Reduction*
- *Alkalinity Reduction and low CO_2 in Steam*
- *Silica Reduction*
- *Organic Matter Reduction*
- *Iron and Manganese Removal*
- *Preferential Magnesium Reduction*



A Graver Hot Process-Hot Zeolite System at a large west coast cooperative steam-producing plant.

Easily the most versatile equipment available to the boiler plant engineer today to treat his feedwater is the Graver Hot Process-Hot Zeolite plant. This system can achieve all or any of these results, usually at most economical cost.

Heating and deaeration can be accomplished in the first stage hot process unit with complete deaeration of oxygen to 0.005 ml/liter whenever required.

Clarification of turbid raw water supplies can be obtained in this stage as can alkalinity, dissolved solids and organic matter reduction. Iron and manganese are also removed here.

By adsorption in the first stage with inexpensive magnesium precipitates, silica can be reduced to less than 1 ppm in the treated water.

This plant utilizes resin zeolite which is selective to magnesium, assuring preferential magnesium reduction. This avoids magnesium phosphate boiler sludge —a troublesome product of the older type hot process-hot phosphate system.

A Graver Hot Process-Hot Zeolite plant assures *constant* zero hardness to the boiler *regardless* of the raw water hardness variation, chemical feed adjustment or load fluctuation.

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Hot Process-Hot Zeolite Softeners

GW478

his research on hydrazine while a student at Cornell, he also worked on azide derivatives of the chemical, which had wide application in World War II.

* * *

W. B. Logan and **F. H. Holmes** have been promoted to assistant general managers of The Texas Co.'s refining department. Previously, Mr. Logan had been refining department manager of operations, and Mr. Holmes had been assistant manager in the same department.

Mr. Logan

Mr. Holmes

Mr. Mangelsdorf

T. A. Mangelsdorf, general superintendent of Texaco's Port Arthur plant since 1950, has been named manager of the operations division in New York.

Mr. Logan is a chemical engineering graduate of the University of Texas and joined The Texas Co. in 1922. In 1934 he was made assistant superintendent of the Lawrenceville, Ill., plant, becoming superintendent in 1939. Since 1942 he has been in the refining department, first as assistant manager and more recently manager.

Mr. Holmes is a 1927 graduate of Yale, and since 1932 has held supervisory positions at numerous Texaco establishments in this country and overseas. In 1945 he became general superintendent at Port Arthur, and was named assistant operations manager in the refinery department in 1950.

After serving as a professor at MIT, Mr. Mangelsdorf joined Texaco in 1933. In 1947 he was named superintendent of the Lockport, Ill., works, and became general superintendent at Port Arthur in 1950.

In other Texaco changes, **L. C. Kemp,** director of research, has been appointed assistant to the vice president, and **Dr. W. J. Coppoc,** formerly associate director of research, succeeds him.

* * *

A. Ludlow Clayden, technical associate in Sun Oil Co.s' chemical research and development department, has retired after 31 years of service with the company.

Mr. Clayden joined Sun as chief automotive engineer in May, 1922. In 1948 he became head of the automotive laboratory at the Marcus Hook, Penna., refinery, and in February of this year was appointed to his most recent post.

Born in Bath, England, in 1883, Mr. Clayden studied mechanical and electrical engineering at Bristol University. In England he was associated with the Daimler Motor Co., affiliated with various trade publications for eight years, and worked as a consulting engineer for Wright-Martin Aircraft Corp. in Europe. Immediately prior to joining Sun he was general consultant to the United States Cartridge Co. in Lowell, Mass.

He is a member of the Society of Automotive Engineers, the Coordinating Research Council, and the American Society for Testing Materials.

* * *

J. A. Boege has been appointed manager of Vernon, Calif., facilities, a new post in the manufacturing department of General Petroleum Corp.

Manager of GP's laboratories since 1945, Mr. Boege studied at the University of California at Los Angeles and joined the company in 1930. He is being succeeded as manager of laboratories by **R. A. Baker,** formerly assistant manager.

* * *

Dr. Carsten C. Steffens has returned to the Stanford Research Institute as technical coordinator of the research divisions. From 1947 to 1949 he served as assistant director of the Institute. A specialist in physics of the atmosphere, he helped initiate SRI's study of smog conditions in Los Angeles in 1947. For the past four years he has been associate professor of chemistry at the University of Mexico.

* * *

Drs. W. F. Hamner, K. M. Taylor and **H. M. Walker,** and **Mr. W. F. Yates** have been promoted from section leaders to group leaders in the Monsanto Chemical Co.'s Texas Division research department.

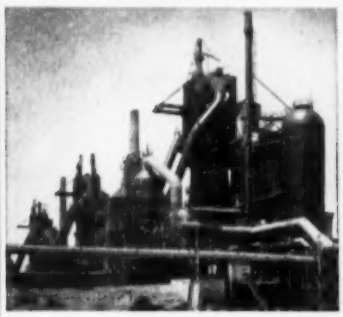
* * *

Dr. Frederick C. Turner has joined Dow Chemical Co.s Texas Division as director of industrial health and medicine. Besides work in the field

what's NEW in Engineering

An automatic welding machine, developed by a Michigan company, is claimed to duplicate the work of dozens of human welders. The octopus-like machine generates temperatures of 2000° F.; is water cooled. One operator can make 62 simultaneous welds with it. In one minute it can perform 744 weld operations.

Reducing coke consumption while increasing pig iron production was the dual problem facing Kaiser Engineers in designing and building blast furnaces for a California steel plant. A courageous new furnace



design gave record results—1335 tons of pig iron per day on furnaces rated for 1200 tons. These furnaces use 1409 lbs. of coke per net ton of iron against a national average of 1600-1700 lbs. per ton. We'll send you a reprint of an article by Dr. W. C. Rueckel which tells how Kaiser Engineers attained this outstanding furnace practice—with savings in capital and operating costs through increased production.

Simplified Drafting Practice, by Healy and Rau, is a best-selling new book which outlines a modern approach to industrial drafting. The method claims to cut drafting time 30-50%; reduce large blueprints to handy pocket size.

For those clients who want general consulting engineering services, such as economic studies, evaluation, investigation of manufacturing facilities, or analysis of operating costs, the full engineering experience of Kaiser Engineers is available. Call or write: Kaiser Engineers Division of Henry J. Kaiser Company, Kaiser Building, Oakland 12, California.

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- √ Each joint rolled automatically to predetermined tightness.
- √ Eliminates slow, costly steprolling.
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- √ Tube sheets protected against distortion, enlargement of holes.

With this new Retractive Method of Tube Expansion, the expander is fully inserted and rolls a short section of the tube. When full expansion is reached, it then automatically starts to retract. Keeps rolling as it retracts, gives full expansion to the tube the entire thickness of the sheet.

To learn more about this efficient new Retractive Method of expanding high pressure tubes—write for your copy of AIRETOOL Bulletin No. 54.

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of industrial health and medicine, this new department has been assigned certain phases of the work previously handled by the hospital and medical department, plus part of that done formerly by the health and safety department.

* * *

George R. L. Shepherd has been promoted to senior research chemist, research and development division, Humble Oil & Refining Co., and **Reuben F. Pfennig** has been appointed a research specialist in the same division.

Mr. Shepherd's assignments will range from fundamental study of catalytic conversion processes to preparation of economics for proposed new processes. Mr. Pfennig will specialize in development and evaluation of petrochemical processes.

* * *

Sherman E. J. Johnsen has been named senior research group leader in the research department of Monsanto Chemical Co.'s Texas Division. Mr. Johnsen came with Monsanto in 1942 as a research chemist at the W. G. Krummrich plant in Monsanto, Ill., later transferring to Marshall and Texas City, Texas. He is a chemistry graduate of the University of Minnesota.

* * *

A. W. G. Trantor has been appointed general manager of Anglo-Iranian Oil Co.'s Aden refinery. He was previously works manager at the firm's Kent refinery on the Isle of Grain, England.

Succeeding Mr. Trantor at the Isle of Grain is **A. Patrickson,** formerly process superintendent at that same location.

* * *

F. Lee Lichtenfels has been named assistant superintendent, process, at the Toledo refinery of Standard Oil Co. (Ohio). He was formerly operations control assistant at the same location.

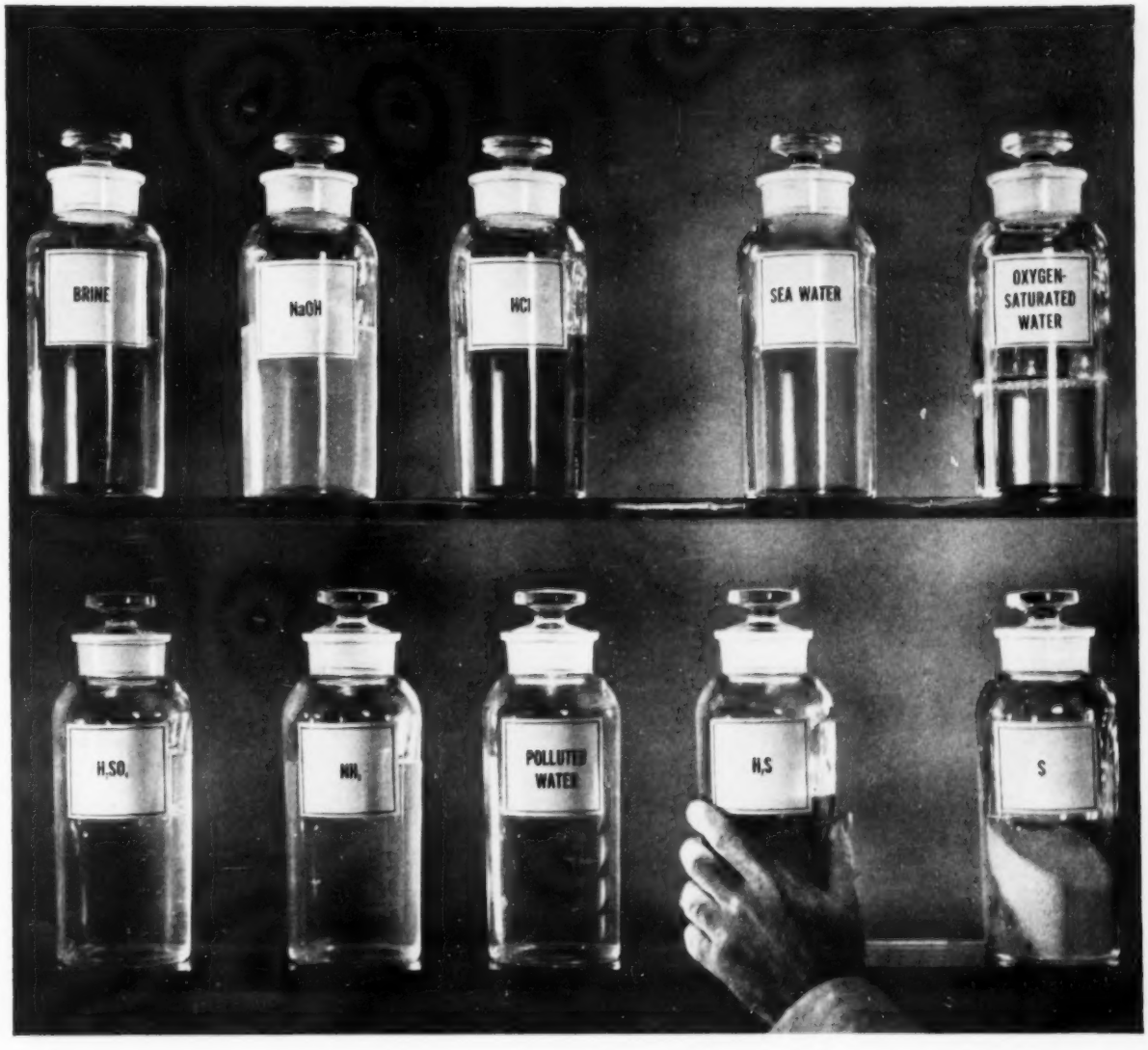
Graduating from Pennsylvania State College in 1937, Mr. Lichtenfels came to Sohio's Toledo refinery in 1939.

* * *

Dr. Robert K. Smith has joined Houdry Process Corp. as chief of the exploratory research section. A graduate of Penn State College and Princeton, Dr. Smith comes to Houdry after doing research work at Standard Oil Co. (N.J.) and Kendall Refining Co.

* * *

Elihu Madison, manager of the economics department of The Texas Co., has been named director of the program division of the Petroleum Administration for Defense. The appointment was effective August 16.



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(To obtain more data on advertised products see page 1400)

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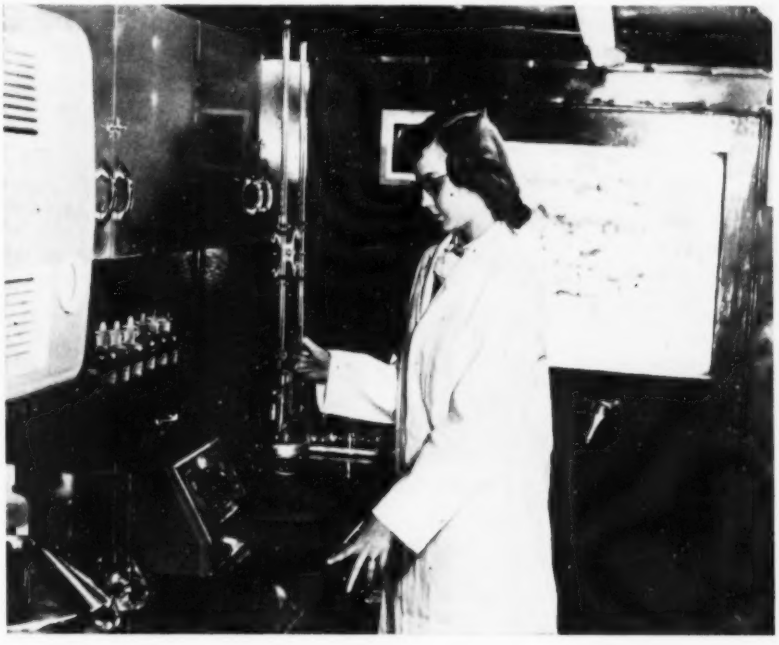


"Standardized" Mobile Lab Tours U. S.

Rolling around the U. S. these days is a new mobile field laboratory developed by Fisher Scientific Co. Designed with a standardized body to cut construction costs, "Mobilab" is said to be adaptable to a wide variety of field research tasks.

Each unit has gas, water and electricity outlets, heat and air conditioning. Sliding partitions can be used to divide the unit into sections for different types of work. In addition to low initial costs, the unit features a compact arrangement of instruments and storage space, with adequate room for operating personnel.

Demonstrations will be held at the American Chemical Society meeting in Chicago, September 6-12, and the Chemical Exposition in Philadelphia, November 30-December 5.

Siciliano New Labor Ass't

Rocco C. Siciliano, supervisor of labor relations for Procon, Inc., has been confirmed by the U. S. Senate as an assistant secretary of labor.

Mr. Siciliano

Mr. Siciliano, also assistant secretary of Procon, a Universal Oil Products Co. construction subsidiary, is expected to begin his new duties in a short time. He is a lawyer and former legal assistant to a member of National Labor Relations Board, having been with Procon since leaving the NLRB in 1950. He received a degree in political science from the University of Utah in 1944, and was awarded a law degree from Georgetown University in 1948.

Benn is Safety Chairman

The National Constructors' Association's new safety chairman is William R. Benn, safety engineer of the H. K. Ferguson Co. Mr. Benn, associated with that firm in Cleveland for the past two years, holds a chemical engineering degree from the South Dakota School of Mines and a degree in metallurgy from Purdue University.

Nat'l Cylinder, Girdler Merge

National Cylinder Gas Co. and the Girdler Corp. have merged, making Girdler a division of National Cylinder Gas. No changes are planned in Girdler Corp. headquarters at Louisville, Ky. Through the marriage, National Cylinder also acquires outstanding stock in Tube Turns, Inc., and Pennsylvania Forge Corp., both former subsidiaries of Girdler. Votator, Gas Processes, and Thermex Divisions will also retain their identities as divisions of Girdler.

Beckman Instrument Award

A $1000 annual award honoring U. S. and Canadian scientists for work in chemical instrumentation has been set up by Dr. Arnold O. Beckman, president, Beckman Instruments, Inc.

To be presented for the first time in spring, 1955, the award will recognize outstanding achievements in development of new instruments for chemical analysis and application of instrument to chemical process measurement and control. Administered by the American Chemical Society, the Beckman Award will give special consideration to originality as well as the value of the contribution in reducing manufacturing costs or improving product quality.

Beard to Foster Engrg.

New research and development engineer at Foster Engineering Co. is Chester S. Beard, president of the New York Section of the Instrument Society of America.

Mr. Beard

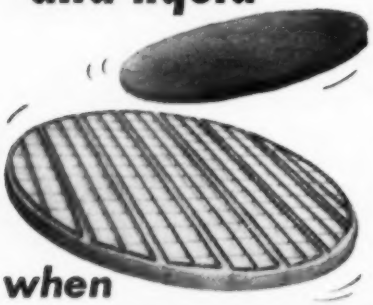
Before joining the Foster organization, Mr. Beard specialized in pipeline and process instrumentation with Ebasco Services, Inc. Earlier he headed instrument groups for Bechtel Corp., Southern California Gas Co., and Permanente Metals Corp. He is the author of many articles dealing with control valves, positioners and other phases of instrumentation.

Egloff Royal Society Member

Dr. Gustav Egloff, director of research for Universal Oil Products Co., has been elected an honorary fellow of the Royal Society of Edinburgh, one of four persons not British subjects who have been so honored this year.

The Royal Society, instituted by charter in 1783 for the promotion of science and literature, includes such world-famed contemporaries as Dr.

CLEAN SEPARATION— *between vapor and liquid*



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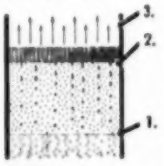
SEPARATORS
EVAPORATORS
KNOCK-OUT DRUMS, ETC.

YORKMESH Demisters (entrainment separators—mist eliminators) have proved to be the answer to higher production and improved products when installed in new or existing equipment.

YORKMESH Demisters (made of finely woven wire) remove substantially all liquid entrainment even at increased vapor velocities. The net result: More production with higher quality.

How YORKMESH Demisters work:

1. Vapor disengaging from liquid creates fine liquid droplets.
2. The liquid droplets impinge and coalesce into large drops and fall off.
3. The vapor is now dry, entirely freed from entrained liquid.



Materials: Types 430, 304, 316 Stainless Steel, Monel, Carbon Steel, etc. Prompt shipment.

Write for new Catalog 13 for complete information and engineering data.

OTTO H. YORK Co., INC.

67 Glenwood Place, E. Orange, N. J.

Albert Einstein, Dr. Enrico Fermi and Dr. James Bryant Conant.

Bechtel Names Three VP's

Fred W. Meyer, Myles C. McGough and A. J. Orselli have been named vice presidents of Bechtel Corp.

Mr. Meyer has been chief engineer of the refinery division for the past five years and will continue in that division. He joined the company in 1942, and became chief engineer in 1948.

Mr. Meyer

Mr. McGough is vice president and general manager of the Eastern Division, being in charge of all domestic operations in New York. He came to Bechtel last year after serving as vice president of a large New York engineering firm. Mr. Orselli, until his promotion manager of construction, Eastern Division, becomes a vice president in the power division.

Replacing Mr. Meyer as chief engineer of the Refinery Division is Russell G. Johnson, a 11-year Bechtel veteran.

Builders Iron Changes Name

Builders Iron Foundry is changing its name to B-I-F Industries, Inc., since the company's original operation, production of castings for building trades, has been largely replaced by manufacture of precision instruments and equipment. Name change, it's hoped, will give a better picture of actual operation, while retaining initials of the original firm, incorporated in 1853.

Nox-Rust to New Home

Into a new plant on September 15th goes Nox-Rust Chemical Corp.

The new facilities, located in Chicago's outskirts, will enable the firm to step up production of rust preventives and petroleum chemicals an estimated 100%.

Concurrently with the plant shift, the company's executive and sales office move to a new headquarters at 333 N. Michigan Ave., Chicago.

Young Expands at Mattoon

Construction is underway on an expansion of existing Young Radiator Co. plant facilities at Mattoon, Ill.

The new plant will be used in design and production of heat transfer units.

Noebels Heads Beckman Div.

Now in charge of the applications engineering division of Beckman Instruments, Inc., is Henry J. Noebels. The appointment follows a step-up in applications engineering activities at Beckman, keyed to field studies of instrumentation for the process industries and research laboratories.

For the past eight years, Mr. Noebels has been in charge of the physical instrumental analytical research laboratory of Heyden Chemical Co. A graduate in research chemistry from Rutgers University, Mr. Noebels is a member of the American Chemical Society, the Instrument Society of America, and several other professional groups.

ADSCO Promotes Kintner

Formerly chief engineer of American District Steam Co., James G. Kintner has been made vice president in charge of engineering.

Mr. Kintner

Mr. Kintner, who is a graduate engineer of Purdue University, will head up a new company construction program to increase its engineering program and expand production facilities.

The new vice president will make his headquarters at the company's main plant and offices in North Tonowanda, N.Y.

Personnel Changes

Askania Regulator Co. — Ralph Eads, Jr., to Texas and Louisiana representative, replacing Dean D. Ault, recently killed in an airplane crash.

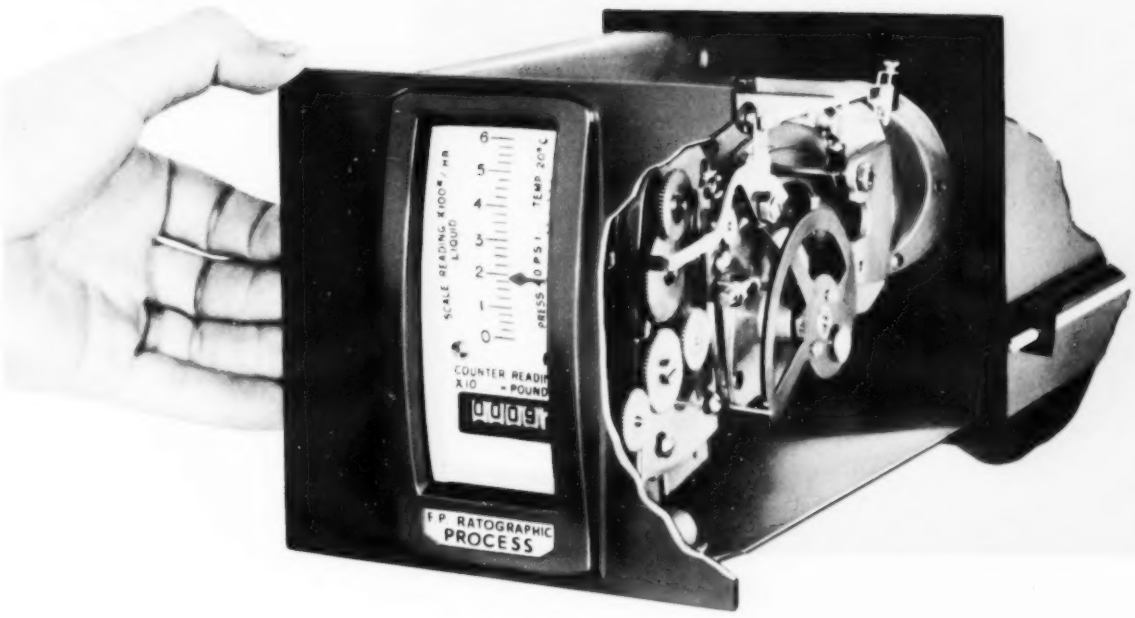
Carlon Products Corp. — Rom Rhome to manager of sales southwestern region, offices at Ft. Worth.

General American Transportation Corp.—Richard H. Lamberton to midwest manager, Plate and Welding Division, headquartering in Chicago.

Air Products, Inc.—Dr. Clyde McKinley to director of research from

NEW

Ratographic* totalizer



complete with continuous rate indication

- continual integration at rate of 24 times per minute
- dust-proof drive mechanism immersed in oil
- heavy duty 100 rpm — 72 pole synchronous motor
- standard size pneumatic receiver and integrator
- front-of-panel accessibility and removal
- accuracy within 1% of full scale

Here, for the first time, is a *full-size*, rugged totalizer — so designed that it can be used in full size, miniature or graphic panels. A companion to the F & P Ratographic miniature indicator, it is another step in complete process instrumentation developed and perfected by the skilled engineers at Fischer & Porter Company.

The entire unit occupies only six inches square of panel space. In extended position, as shown, instrument continues to function, thus easily enables observation of mechanism. The highly accurate integrating unit gives the equivalent of continuous integration. The many other new features combined in this instrument suggest a careful comparison. Full information on request.

*T. M., F&P Co.

complete process instrumentation

FISCHER & PORTER CO.

1190 County Line Road, Hatboro, Penna.

Company owned sales and service branches strategically located throughout the world.

NEW PLATINUM CATALYST PLANT FOR ENGLAND

Universal Oil Products Company has taken an important step to provide adequate quantities of the revolutionary UOP Platforming catalyst in sterling.

Universal and the widely known platinum refining firm of Johnson, Matthey & Company, Limited have formed a subsidiary in England to manufacture and market platinum catalyst. The new company will be known as Universal-Matthey Products, Limited.

Originated and developed by Universal, this platinum catalyst was the very first ever to be offered to the petroleum refining industry. Its effectiveness has been proved through commercial operation in the production of thousands of barrels of both premium gasoline and aromatics from petroleum by the Platforming process. Discovered by Universal, Platforming was the first reforming process to utilize a platinum catalyst to improve the quality of gasoline, and to produce commercial quantities of benzene, toluene and xylenes.

This new catalyst manufacturing plant is but another example of Universal's continuing program of progress designed to offer the broadest possible service to the world-wide petroleum refining industry.

UNIVERSAL OIL PRODUCTS COMPANY

General Offices: 30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.

UOP®

Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Investment

puts the HEAT on heat exchangers

By changing to Yarway Impulse Steam Traps, an oil refinery reports much hotter steam in their heat exchangers **—plus two other important extras:**

(1) They were able to operate the plant with 6 boilers instead of the 8 formerly required.

(2) Three men formerly required to service old-type traps can now be used for productive work.

Significant sidelight—these Yarway traps are operating under severe conditions, many outdoors with temperatures often below zero.

Plant after plant is standardizing on Yarway Impulse Steam Traps because Yarways are designed to deliver the most premium B.T.U.'s at top temperatures into your process or product. **They get equipment hotter, sooner ... and keep it hot.**

Other reasons—small size, easy installation, good for all pressures, only one moving part, low maintenance, low price.

Buy your Yarway Impulse Steam Traps from one of the 216 distributors handling this product.

YARNALL-WARING COMPANY
153 Mermaid Ave., Philadelphia 18, Pa.

ACTUAL SIZE ¾" YARWAY STEAM TRAP

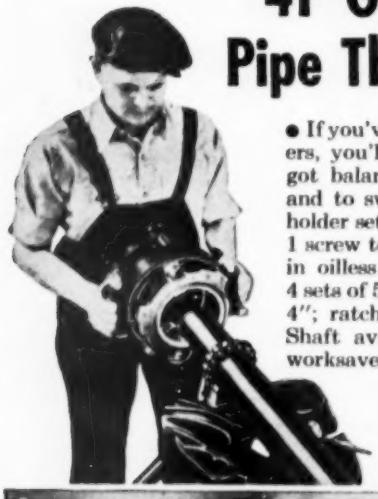
FREE OFFER. Don't take our word for it. Test Yarway's advantages in your own plant, without cost or obligation. Drop us a card or letter—a trial trap will be delivered promptly.

YARWAY the steam trap
designed with more production in mind

RIDGID means most service for your money!

Never before one so easy to carry—
easy to put on pipe...

RIDGID
4P Geared
Pipe Threader



● If you've rassled with old-style geared threaders, you'll go strong on this RIDGID 4P. It's got balanced loop handles—a cinch to carry and to swing onto pipe. Mistake-proof workholder sets to size before it's put on pipe—only 1 screw to tighten. Easy upkeep—drive pinion in oilless bronze bearing; safe enclosed gear. 4 sets of 5 high-speed steel dies, 2½", 3", 3½", 4"; ratchet handle. RIDGID Universal Drive Shaft available — also 4P for conduit. Buy worksaver 4P at your Supply House.

THE RIDGE TOOL COMPANY
ELYRIA, OHIO

RIDGID
Work-Saver Pipe Tools

Suppliers

research staff of General Aniline and Film Corp.

Nuodex Products Co.—A. E. Horn and Richard J. Prentiss to board of directors.

De Laval Turbine Co.—Walter F. Senkus to midwest regional sales representative, with offices in Chicago.

Black, Sivalls & Bryson, Inc. — Chester A. Siver to vice president and general manager of engineering.

Marley Co.—Orville Bloebaum to San Francisco district manager replacing A. C. Elias who died recently.

Cooper Alloy Foundry Co.—Clayton L. Heintz to manager of distribution, a newly-established post.

Lummus Co. — Virgil D. Drummond to post of assistant to vice president Dr. E. R. Smoley.

Branches, Distributors

John Hewson Co. has named H. E. Ransford Co., Grant Bldg., Pittsburgh 22, Pa., as representative for sales, field application and servicing of its line of high voltage D. C. insulation test sets, power supplies, control systems, etc.

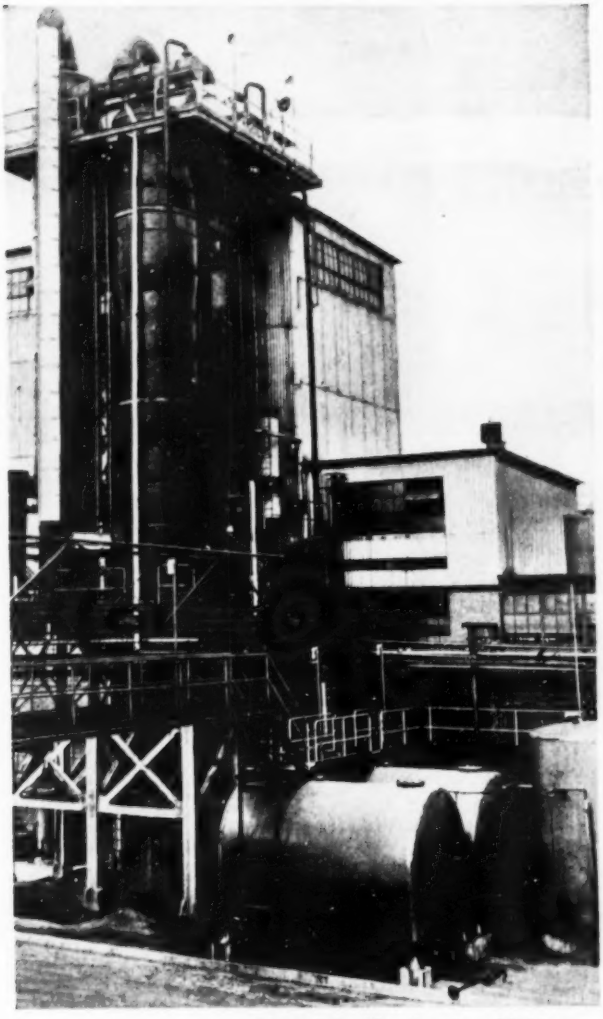
Monsanto Chemical Co.'s Cleveland, Ohio, office is now under the jurisdiction of the Organic Chemicals Division, with Bernard B. Langton as general branch manager. Mr. Langton succeeds R. H. Baugh, who goes to St. Louis as manager of administrative services of the Phosphate Division.

Fluor Corp. has a new foreign affiliate in Lima, Peru. Name of the company is Fluor Peruana, S.A., with offices at 308 Avenide Tacna, Lima, Peru. Ximeno Tejada, former sales engineer in Fluor's New York office, is in charge.

Expansion, Transition

Oliver United Filters, Inc. has acquired manufacture, sales and service rights on the "Centriclone" from the former owners. Equipment Engineers, Inc. "Centriclone" is a combination of a conventional liquid cyclone and a centrifuge for separating solid particles of different sizes and specific gravities when suspended in a liquid slurry.

(To obtain more data on advertised products see page 1400)



Phenol Purification in a Michigan plant. In this type of equipment the effect of corrosion by phenol is amplified by high temperature. To prevent trouble from this source Nickel-Clad Steel is used in fractionating columns, condensers, piping and tanks.

What does Experience Prove...

about protecting Phenol Purity and Safeguarding Equipment?

In the manufacture of synthetic phenol, corrosion is a two-edged sword.

First of all, the acids and alkalies employed in syntheses are extremely corrosive to process equipment. Secondly, even small amounts of metallic corrosion products will seriously affect the color and purity of phenol or phenolic products.

At points where corrosion is mild, it may be practical to accept minor risk . . . but at critical stages, control is essential. Experience has proven that at the majority of danger points, Inco Nickel Alloys are among the most useful common engineering materials.

During the actual manufacture of phenol, for instance, Monel is employed in sulfonators to protect against corrosion by sulfuric and benzene sulfonic acids. In processes which rely on high temperatures or pressures at critical steps, Inconel is used to furnish the necessary corrosion resistance . . . plus high strength characteristics.

In handling phenol itself, product purity is the important factor. Pure nickel equipment is therefore a standard material for storage tanks and tank cars where contact may be for long periods. Nickel is equally important in such applications as stills and fractionating equipment where metallic pickup may be accelerated by high temperatures.

If you make, ship, store, or use phenol, chances are excellent that your corrosion problems will yield to Inco Nickel or one or another of the Inco Nickel Alloys.

Inco's experience with phenol equipment problems can help you find out quickly . . . and easily.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

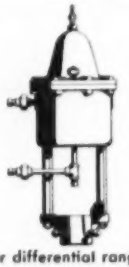
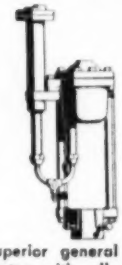
Inco Nickel Alloys

INCO TRADE MARK

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
INCONEL® • INCONEL "X"® • INCONEL "W"® • INCOLOY®
NIMONIC® Alloys • NICKEL • LOW CARBON NICKEL • DURANICKEL®

What's worth metering is worth metering right!

. . . and Foxboro offers the *right* meter for any metering problem. Round and rectangular cases. See the varied types below.

TYPE 22 Meter Body	TYPE 29	TYPE 27 Meter Body	TYPE 28 Meter Body	TYPE 26 Meter Body
				
light weight and low cost, preferred for portable recording, or with 6" indicator, for mounting directly on piping.	for differential ranges as low as 1" H_2O, especially for low pressure gas and air service.	superior general use meter with all Foxboro design features for high sustained accuracy and maintenance-freedom.	longer float travel, greater power, highest accuracy meter ever built.	leakproof measurement at really *high* pressures without compromise in accuracy.

a flow meter type for every need

From its complete line of flow meters, Foxboro can offer the *best* type — in the proper range and static pressure rating — for virtually any metering problem. They are available as indicators, recorders, controllers, and transmitters — with or without integrator. Foxboro also is the maker of the d/p Cell — the compact force-balance type flow transmitter which uses no mercury.

The widest selection of flow instruments is only one of the many factors responsible for Foxboro's acknowledged leadership in flow metering. See how this factor — together with many superior, exclusive design features — give you the most value for your money. Write for Bulletin 460 on mercury meters, Bulletin 420-1 in d/p Cells.

Specifications of Foxboro Meter Types Illustrated

TYPE	MATERIAL	MAX. W. P.	RANGES
22	Forged Steel	2000	20"—200"
29	Cast Iron	150	1" —10"
27*	Forged Steel	2000	10"—400"
28	Forged Steel	2000	50"—400"
26	Forged Steel	5000	100"—400"
d/p Cell	316 S.S.	750-4000	25"—800"

*Type 27U is a uniform flow scale meter used for steam and other service where demand fluctuates widely. 100" range. Max. W. P. 2000 psi.

THE FOXBORO COMPANY, 919 NEPONSET AVENUE, FOXBORO, MASS., U.S.A.

FOXBORO REG. U.S. PAT. OFF. **FLOW METERS**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Toxological Studies on Oil Industry Substances Released by API

ANOTHER series of toxological reviews of substances used or produced by the oil industry has been published by the American Petroleum Institute.

The reviews are designed as reference materials for oil companies and others engaged in chemical activities, particularly oil refiners, whose need for accurate toxicity information has become increasingly important in recent years.

This latest series contains evaluations of 31 substances, ranging from acetic acid to triethanolamine. It is a supplement to the two series issued in 1948, making a total of 63 reviews on toxological materials. A complete listing of reviews is available on a leaflet, obtainable on request.

Studies were planned by API's Medical Advisory Committee, and were prepared at the Harvard School of Public Health under the direction of Professor Philip Drinker.

Single reviews cost 25¢ each, but the three series may be obtained as follows: April, 1948, 14 substances, $3.00; September, 1948, 18 substances, $3.50; June, 1953, 31 substances, $6.50; all three sets, $13.00. American Petroleum Institute, 50 W. 50th St., New York 20, N. Y.

X-Ray Analysis Data In Two Volumes

TWO new books entitled "Data for X-Ray Analysis" have been published as part of the North American Philips Co. Technical Library.

Volume I, 100 pages, by W. Parrish and B. W. Irwin, contains charts for solution of Bragg's equation (d versus θ and 2 θ). Charts cover K radiation for molybdenum, copper, cobalt, iron and chromium. Also included is a table that converts minutes into decimals of a degree.

Volume II, 84 pages, by Mr. Parrish, Mr. Irwin and M. G. Ekstein, contains tables for computing the lattice constant of cubic crystals. Tables give K radiation values for the square root of N times wavelength divided by 2 for copper, nickel, cobalt, iron and chromium. This volume also contains a table giving $\sin^2 \theta$ values in 0.1 degree steps from 10° to 89°, a table giving values for $\frac{1}{2}(\cos^2 \theta/\sin \theta + \cos^2 \theta/\theta)$ in 0.1 degree steps from 10° to 88°, a table giving lattice constants of cubic substances, and a chart showing 33 representative cubic diffraction patterns.

Each of these two volumes costs $2.00 and is available from the Research and Control Instruments Division, North American Philips Co., 750 S. Fulton Ave., Mt. Vernon, N. Y.

A third volume, which will give the X-ray reflection angles for several standard substances (silicon, aluminum, quartz, etc.) is now in preparation.

New Hydrocarbon Constant Volume Now Available

Physical Constants of Hydrocarbons, Vol. V, by Gustav Egloff; 6 x 9 in., ix + 524, stiff cloth cover, $20.00. Reinhold Publishing Corp., 330 W. 42nd St., New York 36, N. Y.

LATEST in the American Chemical Society Monographs on hydrocarbon physical constants, this volume deals with paraffins, olefins, acetylenes and other aliphatic hydrocarbons. It includes data made available since the publication of Vol. I in 1939, which contains similar information. When a compound is given in Vol. V which has already been noted in Vol. I, the page on which the compound appears is noted, and if the structural formula has already been given, it is not repeated.

As in the other works of this series, literature sources are extensive and cross-referenced. As the book itself mentions, data for aliphatics with more than eight carbon atoms is restricted to but a few of the possible isomers, leaving room for much research before all their physical constants are known.

British Book Discusses Atmospheric Pollution

Atmospheric Pollution, Its Origins and Prevention, by A. R. Meetham; 5½ x 8¾ in., viii + 268 pp., indexed stiff cloth cover, $4.90. Pergamon Press Ltd., 2, 3 & 5 Studio Place, London, England.

CHIEF cause of atmospheric pollution, according to this work, is contamination from the combustion of coal and its allied materials. So the major part of the book is an attempt to show how sulphur dioxide, smoke and ash invade the air, and how their attack can be prevented.

Chapters are included on the origin of fuels, natural fuels, artificial fuels, industrial boilers and furnaces, and the distribution of pollution. It should be noted that while the study of pollution problems as a whole is comprehensive, specific figures and data are based on tests in Great Britain alone. The section on anti-pollution laws is almost exclusively on British regulations, although there is a short section on U. S. smoke abatement stipulations. A brief index concludes the volume.

MCA Issues Two New Safety Data Sheets

SAFETY recommendations on sulfur dioxide (SD-52) and hydrogen peroxide (SD-53) have been released by the Manufacturing Chemists' Association.

The sulfur dioxide safety data sheet is 16 pages and contains a listing of important physical and chemical properties and the hazards usually associated with the chemical's handling. Shipment by cylinder and tank car is discussed, with precautions on loading and unloading given. Storage problems are considered, and in case accidents do occur, first aid measures are outlined.

The pamphlet on hydrogen peroxide is handled with a similar format, and also contains samples of recommended labeling.

Both publications are 25¢ each, and are obtainable from the Manufacturing Chemists' Association, 246 Woodward Bldg., Washington 5, D. C.

Measurement Methods On Power Performance

Measurement Techniques in Mechanical Engineering, by R. J. Sweeney; 6 x 9 in., x + 309 pp., indexed, stiff cloth binding. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.

THEORY and practical knowledge are given equal weight in this book on the measurement techniques commonly used in performance testing of such power equipment as engines, pumps, compressors, and combustion and heat transfer apparatus.

The book outlines the principles on which measuring instruments are designed, and tells as well their limitations in ordinary use. Chapters are broken down into kinds of instrumentation service performed, and subdivided into specific types. Main headings include mensuration, mass, time and speed, electrical measurements, dynamometers, pressure, temperature, fluid flow, calorimetry, chemical analysis and automatic controls. There is an appendix containing temperature-

What It's Like In A Bubble Tower . . .

MERIAM MANOMETERS Reveal

Front and back views of an instrumentation cell indicate the exhaustive studies of bubble tray design made by C F Braun & Co, Alhambra, Calif., leading engineers and constructors for the petroleum, chemical and metals industries.

As part of a series of critical tests in bubble tray development, at the C F Braun & Co Research Center, these Meriam Manometers secure the following vital information:

1. Pressure differential across bubble trays.
2. Depth of liquid on individual trays.

If you require primary standards of measurement for pressure or flow of liquids or gases, there is a Meriam Instrument to do the job accurately, quickly and at low cost. We shall be glad to share our more than 40 years of experience in instrumentation with you. Ask for Catalog C-12.

THE MERIAM INSTRUMENT CO.
10989 Madison Avenue • Cleveland 2, Ohio
WESTERN DIVISION: 4760 E. OLYMPIC BLVD., LOS ANGELES 22, CALIF.
IN CANADA: PEACOCK BROS., LTD., MONTREAL

MERIAM Instruments
ESTABLISHED 1911
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

EMF conversion charts for thermocouples, and a comprehensive index.

NBS Publishes Atlas On OH Spectra

A Spectrophotometric Atlas of the $^2\Sigma^+ - ^2\pi$ *Transition of OH*, by Arnold M. Bass and Herbert P. Broida, National Bureau of Standards Circular 541, 22pp., 20¢ U. S. Government Printing Office, Washington 25, D. C.

THIS spectrum atlas of OH has been prepared by the National Bureau of Standards as the first in a series showing relative intensities as well as wavelengths. NBS says it is publishing the atlas to begin fulfilling the need long felt by industry for a study of intensity relationships in spectra.

The circular discusses methods of studying intensity distributions among rotational lines of electronic band spectra, describes the experimental equipment and method used, and includes literature references and 21 spectra charts.

Refiners Glossary Contains Over 2,000 Oil Terms

Glossary of Terms Used in Petroleum Refining, prepared by Committee on Petroleum Products, American Petroleum Institute; 8½ x 10 in., 188 pp., stiff cloth cover, $6.00. American Petroleum Institute, 50 W. 50th St., New York 20, N. Y.

THE American Petroleum Institute has just published a new "Glossary of Terms Used in the Petroleum Refining Industry," which gives a pronunciation key and definition to over 2,000 words and phrases commonly used in refining operations.

The work is a result of over five years labor on the part of API's Committee on Petroleum Products. In compiling the glossary, the committee made no attempt to establish original definitions, but collected all available printed material, and catalogued those terms which were applicable. Where a variety of definitions existed, a definition acceptable to all members of the committee was used.

The book is bound in red cloth and is 188 pages long. It contains a pronunciation key and glossary of terms.

The volume should prove a boon not only to refining executives, but to their secretaries, since the book is concluded with an appendix containing short hand symbols for each of the technical terms discussed.

Orders for the work should be sent to Lacey Walker, Secretary, American Petroleum Institute, 50 W. 50th St., New York 20, N.Y. Price is $6.00 per copy.

(To obtain more data on advertised products see page 1400)

THIS YOUNG TUBE-AND-FIN
CORE PAYS A BONUS!
● PERMANENT, PERFECT BOND BETWEEN TUBES AND FINS
● GREATER HEAT TRANSFER EFFICIENCY
This die-formed collar provides a tight, permanent bond along entire length of tube as shown in cross section at left.

Here's why Young-designed and built tube and plate fin cores give greater heat transfer efficiency . . . stand up better under peak capacity operation . . . pay bigger dividends in longer trouble-free service. The outstanding design and construction of the Young plate type fin core, shown above, features specially die-formed reinforced collars which make a continuous, ***permanent*** bond between fins and tubes . . . providing maximum heat transfer and greatly stronger, longer-lasting cores.

This mechanical structure of greater strength which permits the use of the most desirable metals chosen for the job — copper, aluminum or other alloys — is attributable to Young's precision-manufactured, high-quality cores.

Whatever your need, consult your nearest Young Sales Representative to help you select correct cores — types and sizes — and discuss any phase of your heat transfer problems.

OIL FIELD REPRESENTATIVES:

J. R. MEEK COMPANY, 1341 S. Boston St., Rm. 109, Tulsa
FLOURNOY & EVERETT, INC., 5043 Santa Fe Ave., Los Angeles
HAROLD J. YOUNG, 206 Montgomery Bldg., Muskegon.
JONES & LAUGHLIN STEEL CORP., Supply Div., 106 Main St., Bradford Penn.; Union Commerce Bldg., Cleveland; 401 Liberty St., Gateway Center, Pittsburgh; Clarksburg, W. Va
Other Representatives in Principal Cities

One of our many important installations is the Reynolds Metals Company's new San Patricio, Texas plant which uses more than 80 Young units featuring the new "bonus" core for cooling engine jacket water and lube oil, and 91 additional units of Young variated, specially designed construction.

YOUNG RADIATOR COMPANY

Dept. 263-J, Racine, Wisconsin
Plants at Racine, Wisconsin and Mattoon, Illinois

YOUNG

Heat Transfer Products for Automotive, Agricultural, Industrial, Gas and Diesel Engine Applications

Heating, Cooling, Air Conditioning Products for Home and Industry

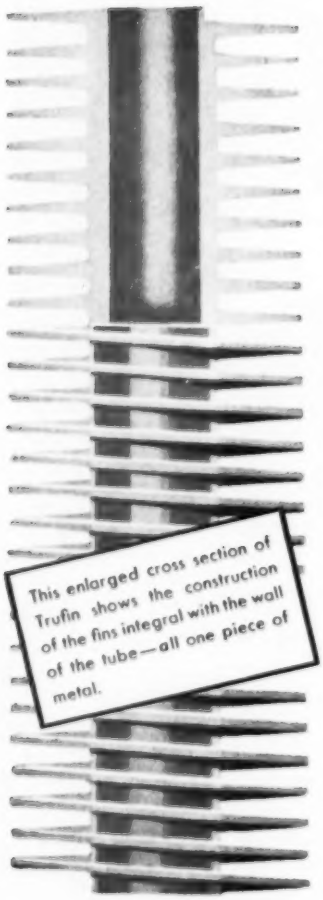
Leaders in Heat Transfer Engineering for more than 25 years

Why Waste Valuable Space?

YESTERDAY YOU REQUIRED THIS MUCH SPACE

TOMORROW WITH WOLVERINE TRUFIN® YOU CAN REALIZE THE SAME EFFICIENCY IN THIS SMALLER SPACE

This is a graphic picture of what Trufin can do for you. It's worth investigating.



This enlarged cross section of Trufin shows the construction of the fins integral with the wall of the tube—all one piece of metal.

Reduce Size! Reduce Costs!

Because Trufin has an exceptionally wide range of outside-to-inside surface ratio, the opportunity for saving space in heat transfer installation is obvious.

A heat transfer unit or condenser, tubed with Trufin, will occupy a fraction of the space of a unit tubed with plain tube of the same capacity. In this regard you can enjoy one of two advantages: the required capacity in an extremely compact unit or a remarkable increase in capacity in your existing space.

In addition, Trufin, the integral finned tube, has these advantages:

As a one-piece finned tube, Trufin will withstand vibrations, shock and sudden temperature changes.

The clean, smooth surface of the fins helps prevent accumulation of dirt and foreign objects, thus retaining the heat transfer ability of the tube.

Trufin can be bent or formed as easily as plain tubing without loss of adequate fin contact.

Trufin is available in a variety of fin spacings, fin heights and alloys, including ferrous or nonferrous metals to meet your specific corrosion requirements.

Let us tell you more about this unusual Trufin. Would you like a data sheet?

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

*REG. U.S. PAT. OFF.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.

ESTABLISHED 1916

Manufacturers of Quality-Controlled Tubing

1425 CENTRAL AVENUE • DETROIT 9, MICHIGAN

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

NGAA Schedules Two-Day Analysis Seminar in Fort Worth this Month

PRACTICAL aspects of hydrocarbon analysis will be the subject of a two-day seminar to be conducted by the Natural Gasoline Association of America in the Texas Hotel, Fort Worth, September 21-22. A number of authorities will give detailed discussions of various analytical methods to a group of laboratory technicians and supervisors expected to number over 200.

Using classroom arrangement and procedure, the seminar will consist of a series of lectures, quiz panels, question periods and demonstrations. First day sessions include talks by S. T. Preston, instructor for NGAA's analysis program, covering all phases of low temperature fractional analysis of both gases and liquids; S. L. Cahn, Beckman Instruments, Inc., on analysis by infrared spectroscopy; and A. P. Gifford, Consolidated Engineering Corp., on hydrocarbon analysis by mass spectrometer.

Second day sessions will be devoted to discussions of low temperature fractionation techniques and auxiliary methods in forums led by Mr. Preston; Dan Smith, chief, Phillips Petroleum Co. analytical laboratory; and Dr. Walter J. Podbielniak, Podbielniak, Inc.

M. F. Wirges, Cities Service Oil Co., is chairman of the program committee.

Offer Cobalt Radiography Fall Training Course

THIS fall Technical Operations, Inc., offer the first in a series of two-week training programs in cobalt 60 radiography. The program is to cover health physics, handling of cobalt 60 and other gamma sources, and the practical and theoretical aspects of industrial radiography.

Training period will be split half and half between lectures and demonstrations and actual experimentation. Applicants should have previous technical training or experience in fields related to foundry practice, steel fabrication, mechanical engineering or radiography.

Further details can be obtained by writing Technical Operations, Inc., 6 Schouler Court, Arlington 74, Mass.

API Forms Crude Oil Testing Committee

THE American Petroleum Institute has created a special committee to develop a symposium on the measuring, sampling and testing of crude oil and petroleum products. First meeting of the committee will be in St. Louis, September 21-22, to lay groundwork for the symposium, to be held at the Institute's 34th annual meeting in Chicago in November, 1954.

The symposium was proposed by the Advisory Committee of the Committee on API Code 25 because of the need to correlate and publicize data on analysis of crudes and manufactured products. Chairman of the new committee is H. C. Packard. (See "Personals," page 1377.)

Move Chemical Industries Show to Philadelphia

THE Exposition of Chemical Industries, held in New York City almost continually since 1915, has been switched to the Commercial Museum and Convention Hall, Philadelphia, for its 24th biennial run, November 30-December 5. The move will allow for a big increase in exhibitor space.

API Refining Div. Shifts '54 Meet to Rice Hotel

A CHANGE in plans has made it necessary to move the 19th midyear meeting of the API Division of Refining to the Rice Hotel in Houston, according to William T. Gunn, director of the division. It had previously been scheduled for the Shamrock Hotel in the same city.

The dates remained unchanged—May 10-13, 1954.

Oil Man's Calendar

SEPTEMBER

National Petroleum Ass'n, annual meeting, Traymore Hotel, Atlantic City, N. J., Sept. 16-18.

Chemical Market Research Ass'n, fall meeting, Pocono Manor Inn, Pocono Manor, Pa., Sept. 17-18.

Instrument Society of America, 8th national conference and exhibit, Hotels Sherman and Morrison, Chicago, Ill., Sept. 21-25.

Natural Gasoline Ass'n of America, fractional analysis seminar, Texas Hotel, Ft. Worth, Tex., Sept. 21-22.

Western Petroleum Refiners Ass'n, regional meeting, Hotel Henning, Casper, Wyo., Sept. 24-25.

American Society for Testing Materials, Committee D-2 meeting, Shoreham Hotel, Washington, D. C., Sept. 25-Oct. 2.

American Society of Mechanical Engineers, petroleum division, annual conference, Rice Hotel, Houston, Sept. 28-30.

OCTOBER

California Natural Gasoline Ass'n, 28th annual meeting, Ambassador Hotel, Los Angeles, Oct. 8-9.

American Institute of Chemical Engineers, Tulsa and Oklahoma Sections, fall meeting, College High School, Bartlesville, Okla., Oct. 10.

Packaging Institute, 15th annual Forum, Hotel Statler, New York City, Oct. 12-14.

Scientific Apparatus Makers Assn., mid-year meeting of the recorder-controller section, Seaview Country Club, Absecon, N. J., Oct. 14-16.

American Institute of Chemical Engineers, South Texas Section, 8th annual technical meeting, Galveston, Texas, Oct. 16.

Society of Industrial Packaging and Materials Handling Engineers, exposition technical short course and competition. Mechanics Hall, Boston, Mass., Oct. 18-24.

American Institute of Chemical Engineers, New York Section, symposium on management, new construction materials, solids handling, Hotel New Yorker, New York City, Oct. 22.

Western Petroleum Refiners Ass'n, regional meeting, Garrett Hotel, El Dorado, Ark., Oct. 22-23.

Natural Gasoline Ass'n of America, regional meeting, Blackstone Hotel, Tyler, Texas, Oct. 24.

Association of Consulting Chemists and Chemical Engineers, annual meeting (25th anniversary), Hotel Belmont-Plaza, New York City, Oct. 27.

NOVEMBER

Packaging Association of Canada, annual convention, Toroto, Nov. 1-7.

American Oil Chemists Society, fall meeting, Sherman Hotel, Chicago, Nov. 2-4.

American Institute of Electrical Engineers, fall general meeting, Hotel Muehlebach, Kansas City, Nov. 2-6.

Society of Automotive Engineers, national fuels and lubricants meeting, Conrad Hilton Hotel, Chicago, Nov. 5-6.

American Petroleum Institute, annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Nov. 9-13.

Natural Gasoline Ass'n of America, regional meeting, Herring Hotel, Amarillo, Texas, Nov. 21.

Chemical Industries Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa., Nov. 30-Dec. 5.

DECEMBER

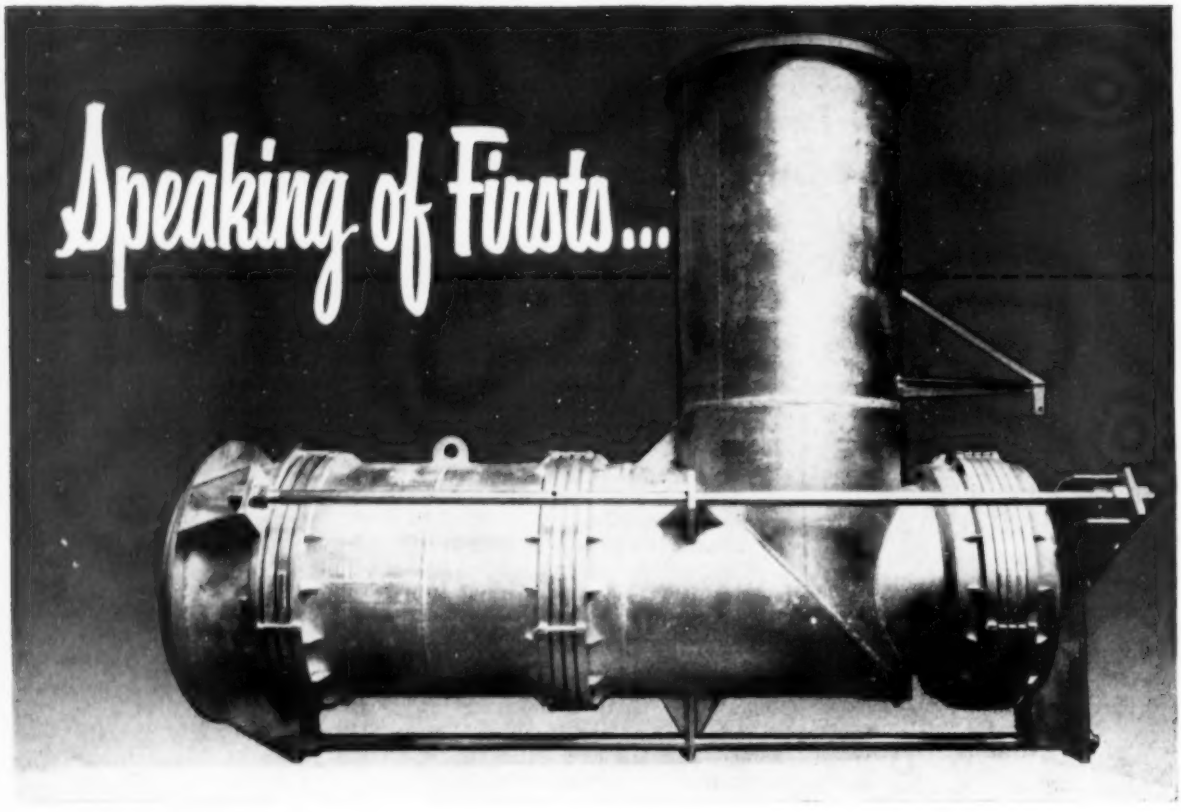
Chemical Specialties Manufacturers Ass'n, Annual meeting, Mayflower Hotel, Washington, D. C., Dec. 6-8.

Scientific Apparatus Makers Ass'n, laboratory apparatus, laboratory equipment and optical sections, mid-year meeting. Boca Raton Club, Boca Raton, Fla., Dec. 7-10.

American Chemical Society, regional conclave, Jung Hotel, New Orleans, La., Dec. 10-12.

American Institute of Chemical Engineers, annual meeting, Hotel Jefferson, St. Louis, Mo., Dec. 13-16.

American Chemical Society, 1953 Symposium on "Flow Through Porous Media," University of Michigan, Ann Arbor, Dec. 28-29.



Recently, Zallea was given the assignment of developing a group of 48-inch expansion joints for flight propulsion test facilities on a classified defense project. The rigid technical specifications of this advanced application required "tailor-made" units for the job, so Zallea engineers analyzed the problem and designed the unusual-looking joint pictured above . . . the first of its kind. Actually, it is a Balanced Pressure, Universal Self-equalizing expansion joint, originally developed by Zallea engineers in 1945, operating at 165 psi and incorporating internal stainless steel turning vanes to provide a smooth flow of gases through the right angle bend. The unit absorbs 3" axial and 1.27" lateral movements through a temperature range from −100° F. to +650° F. No anchors are required since this arrangement neutralizes end thrust developed by internal pressures.

This example is representative of our ability to cope with the most difficult expansion joint problems. It is our business to specialize in the design and manufacture of one product only—expansion joints—and over the years we have learned how to solve the "tough ones" effectively and quickly.

Zallea Expansion Joints are available in diameters from 3 inches to 30 feet . . . for temperatures from sub-zero to 1600° F. . . . for pressures from vacuum to 300 psi in standard designs, and up to 2,000 psi in special designs.

The next time you are faced with an expansion problem, get in touch with us. We will be glad to survey your situation and recommend the most practical and economical solution. Zallea Brothers, 822 Locust Street, Wilmington 99, Delaware.

For detailed information on Zallea Expansion Joints and services write today for a free copy of Bulletin 351.

Zallea
EXPANSION JOINTS

 (To obtain more data on advertised products see page 1400)

Forecasts are for Higher Crude Runs Despite Top-Heavy Product Stocks

Outlook: Runs to stills will trend higher, to around 7,100,000 b/d avg. by late fall . . . Moderate withdrawals of gasoline stocks, but in all refining areas stocks will run considerably higher than last fall . . . Gasoline demand will remain high . . . In only the East Coast, Gulf Coast and California districts will distillate stocks be greatly higher than last fall.

MARK TWAIN'S remark about everyone talking about the weather but no one doing anything about it has a new twist, in connection with the consideration of requirements for crude runs to stills this coming fall and winter.

The three published forecasts, based on normal winter temperatures, call for total runs of above 7,000,000 b/d avg. for the fourth quarter of '53 and the early months of next year. The PAD forecast of supply and demand, made in August, is for 7,100,000 b/d currently and for an average of 7,200,000 b/d over the 9 months to July 1, 1954. The Independent Petroleum Assn. of America, in an earlier forecast, estimated runs for the last quarter at 7,012,000 b/d and 7,095,000 b/d for the first quarter of '54. The Bureau of Mines has revised its forecast of fourth quarter requirements to 7,044,000 b/d avg.

The key to crude oil runs at refineries during the winter is the anticipated volume of distillate needed, together with stocks on hand, to supply our heating oil needs. The yardstick for this estimate which has been used, is the volume of oil the number of burners installed will use in a normal winter.

The debate is whether the estimate should be based on a "normal" winter. Those who think runs are too high point out that we have had winters of above-normal temperatures, nationwide, for the past 5 years and that the long-range trend is toward milder winters, particularly in the eastern and New England areas, where heating oil consumption is concentrated.

Their reasoning is that refiners should go into the winter reasonably prepared to meet demand, and then watch the weather. With tanks full down the line to consumers, they believe the companies are able to meet higher than anticipated demand early in the winter, should it develop. Additional refining capacity could then be called into use, if necessary, to meet late winter requirements. In short, these companies believe the industry is talking about the winters being milder but is not doing anything about it. They say that not recognizing this fact a year ago brought refiners into early April, '53, with stocks of kerosine and distillate combined, about 15,000,000 bbls. higher than the preceding April.

A straw in the wind, in regard to crude oil requirements, may be the action of the Texas Railroad Commission in cutting this state's allowable production by 119,691 b/d avg. from August, to 3,005,443 bbls. for September. Almost unanimously, producers recommended reducing the rate of flow. The Commission noted that oil companies told it last spring that the end of the current touring season would find refiners with about 122,000,000 bbls. of gasoline in their tanks, while there was actually on August 15th, 143,500,000 bbls.

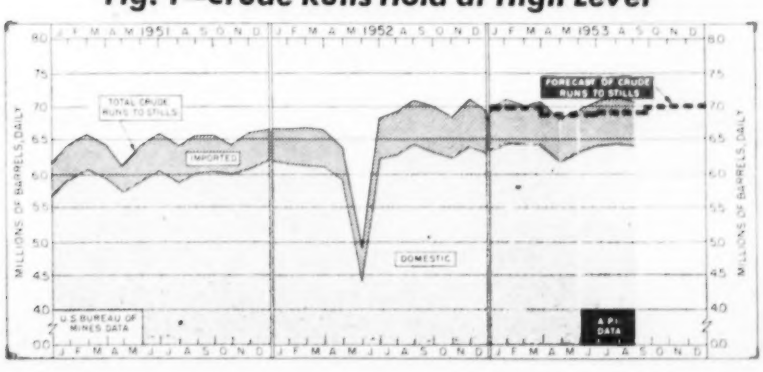
Table 1 compares refiners' inventories of the four principal products on hand Aug. 15 with Aug. 16 a year ago, by refining districts. Of the 33,457,000 bbls. (13.3%) increase this year east of California, nearly 22,000,000 bbls. is in gasoline and about 12,400,000 bbls. in distillates. The overage in gasoline stocks is evenly distributed over the various districts. The surplus in distillate stocks, however, is confined to the East Coast and Gulf Coast areas. Here distillate stocks Aug. 15 were over 12,000,000 bbls. higher than on the comparable 1952 date.

Table 1—Stocks of Major Refinery Products, by Refinery Districts, Aug. 15, 1953, Compared with 1952

(Thousand barrels, API Data)

	Aug. 15, 1953					Aug. 16, 1952					Change '53 over '52	% Change
	Gasoline	Kero.	Dist.	Resids.	Total	Gasoline	Kero.	Dist.	Resids.	Total		
East Coast	51,294	13,162	37,958	12,773	98,187	28,979	12,697	23,485	12,804	87,965	+10,222	11.6
Gulf Coast	26,660	6,518	21,698	9,038	63,904	21,644	5,953	13,870	10,221	51,388	+12,516	24.4
TotalCoastal	69,954	19,680	59,656	21,811	162,091	50,623	18,650	47,055	23,025	139,353	+22,738	16.3
Appalachian	4,948	1,054	1,821	895	8,718	5,311	915	1,928	1,228	9,382	— 664	7.2
Ind.-Ill.-Ky.	28,343	7,867	19,039	4,484	59,733	24,459	6,455	19,574	6,452	56,940	+ 2,793	4.9
Okla.-Kan.-Mo.	15,975	2,314	12,022	1,211	31,522	11,028	1,876	11,974	1,615	26,493	+ 5,129	15.6
Other Inland	14,171	1,418	5,341	2,807	23,740	10,189	1,451	4,940	2,699	19,279	+ 4,461	23.1
Total Inland	62,540	12,653	38,223	9,397	122,813	50,987	10,697	38,416	11,994	112,094	+10,719	9.5
Total East of Cal	123,494	32,333	97,879	31,208	284,904	101,610	29,347	85,471	35,019	251,447	+33,457	13.3
California	20,083	402	12,858	19,025	52,368	14,369	374	9,809	16,940	41,492	+10,876	26.2
Total U.S.	143,577	32,735	110,737	50,233	337,272	115,979	29,721	95,280	51,959	292,939	+44,333	15.1

Fig. 1—Crude Runs Hold at High Level


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS DAILY
TOTAL CRUDE RUNS TO STILLS
IMPORTED
DOMESTIC
FORECAST OF CRUDE RUNS TO STILLS
U.S.BUREAU OF MINES DATA
API DATA

Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
Aug. '53 API*	6,434	651	7,085
Aug. '52 BM	6,487	631	7,118
Change	— 53	+20	— 33
% Change	0.8	0.3	0.5

* Through Aug. 22

Total (1000 bbls.)
(Bureau of Mines Data)

7 Mos. '53*	1,349,725	134,103	1,483,828
7 Mos. '52	1,259,150	110,620	1,369,770
Change	+90,575	+23,483	+111,059
% Change	7.1	21.2	8.3

* June & July estimated from API data

BM Data on Crude Runs to Stills, 1953
(July 30, 1953; 1000 b/d avg. by quarters)

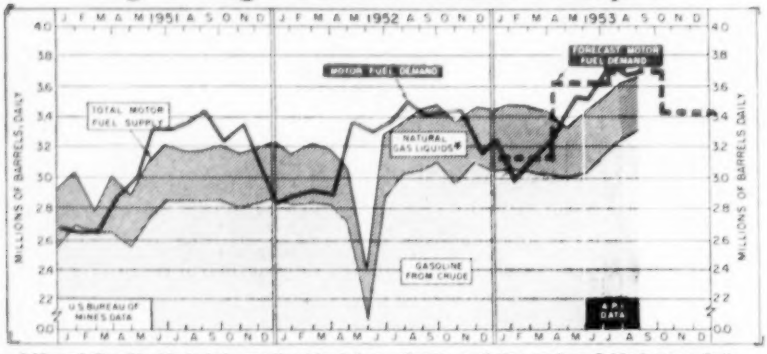
Actual	Estimated	Forecast
1st Q.,7,666;	2d Q.,6,959;	3d Q.,6,991; 4th Q.,7,044

Yields on Crude Runs to Stills

	Gasoline	Kerosine	Dist. Fuels	Resid. Fuels
	%	%	%	%
Aug. '53 API*	46.7	4.5	20.3	17.6
July '53 API	45.7	4.7	20.5	17.6
June '53 API	45.1	4.7	20.9	17.3
Aug. '53 BM	43.3	5.3	21.2	17.6

* Through Aug. 22.

Fig. 2—High Rate of Gasoline Output


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, DAILY
FORECAST MOTOR FUEL DEMAND
MOTOR FUEL DEMAND
TOTAL MOTOR FUEL SUPPLY
NATURAL GAS LIQUIDS*
GASOLINE FROM CRUDE
U.S. BUREAU OF MINES DATA
A.P.I. DATA

* Natural Gas Liquids include gasoline blended at refineries, and that used as finished motor fuel.

Fig. 3—Pull on Gasoline Stocks Eases Off

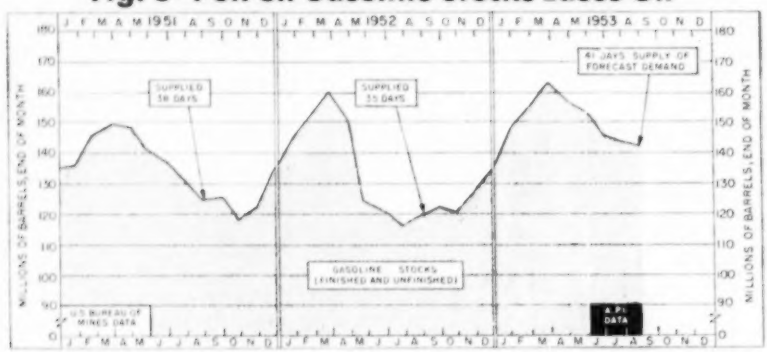

J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 38 DAYS
SUPPLIED 35 DAYS
41 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED AND UNFINISHED)
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Fig. 4—Seasonal Slack in Heating Oil Demand

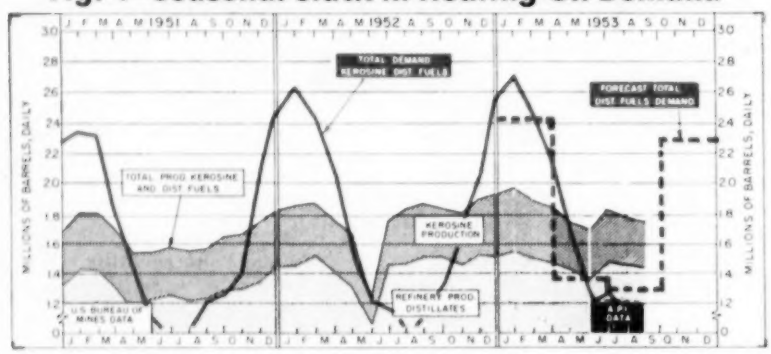
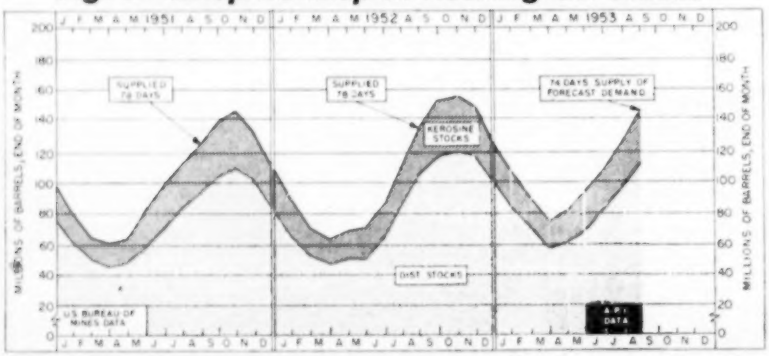

J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, DAILY
TOTAL DEMAND KEROSINE DIST FUELS
FORECAST TOTAL DIST FUELS DEMAND
TOTAL PROD KEROSINE AND DIST FUELS
KEROSINE PRODUCTION
REFINERY PROD DISTILLATES
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Fig. 5—Steep Buildup in Heating Oil Stocks


J F M A M 1951 A S O N D
J F M A M 1952 A S O N D
J F M A M 1953 A S O N D
MILLIONS OF BARRELS, END OF MONTH
SUPPLIED 78 DAYS
SUPPLIED 78 DAYS
74 DAYS SUPPLY OF FORECAST DEMAND
KEROSINE STOCKS
DIST STOCKS
U.S. BUREAU OF MINES DATA
A.P.I. DATA

Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
Aug. '53 API*	3,310	360	3,670
Aug. '52 BM	3,088	377	3,465
Change	+222	−17	+205
% Change	7.2	4.8	5.9

* Through Aug. 22.

Total (1000 bbls.)
(Bureau of Mines Data)

7 Mos. '53*	658,638	78,905	737,543
7 Mos. '52	582,176	79,002	661,178
Change	+76,462	−97	+76,365
% Change	13.1	0.1	11.5

* June & July estimated from API data.

Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

Aug. '53 API*	3,720
Aug. '52 BM	3,416
Change	+304
% Change	9.2

* Through Aug. 22.

Total (1000 bbls.)
(Bureau of Mines Data)

7 Mos. '53	726,495
7 Mos. '52	679,116
Change	+47,379
% Change	7.0

* June & July estimated from API data.

Data on Motor Fuel Demand, 1953
(July 30, 1953; 1000 b/d avg. by quarters)

Actual	Estimated	Forecast
1st Q. 3,150;	2d Q. 3,610;	3d Q. 3,674; 4th Q. 3,435

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

Aug. '53 API*	142,334
July '53 API	143,426
June '53 API	145,907
Aug. '52 BM	119,592

*Aug. 22.

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Aug. '53 API*	319	1,440	1,759
Aug. '52 BM	375	1,514	1,889
Change	−56	−74	−130
% Change	15.2	4.9	7.0

* Through Aug. 22.

Total (1000 bbls.)
(Bureau of Mines Data)

7 Mos. '53*	77,287	311,588	388,875
7 Mos. '52	74,410	292,017	366,427
Change	+2,877	+19,571	+22,449
% Change	3.9	6.8	6.1

*June & July estimated from API data.

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
Aug. '53 API*	178	912	1,090
Aug. '52 BM	213	928	1,141
Change	−35	−16	−51
% Change	16.0	1.7	4.5

* Through Aug. 22.

Total (1000 bbls.)
(Bureau of Mines Data)

7 Mos. '53*	73,457	309,218	382,675
7 Mos. '52	74,111	296,073	370,184
Change	−654	+13,146	+12,491
% Change	0.9	4.4	3.4

*June & July estimated from API data.

BM Data on Heating Oils Demand, 1953
(July 30, 1953; 1000 b/d avg. by quarters)

Actual	Estimated	Forecast
1st Q. 2,459;	2d Q. 1,398;	3d Q. 1,283; 4th Q. 2,321

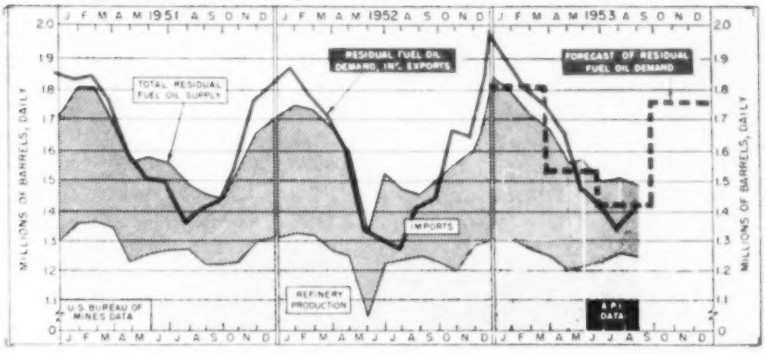
Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
Aug. '53 API*	33,769	113,601	147,370
July '53 API	30,672	102,002	132,674
June '53 API	27,340	84,395	111,735
Aug. '52 BM	32,401	104,257	136,658

*Aug. 22.

Fig. 6—Small Upturn in Residual Demand



Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
Aug. '53 API*	1,245	253	1,498
Aug. '52 BM	1,252	215	1,467
Change	−7	+38	+31
% Change	0.6	17.7	2.1

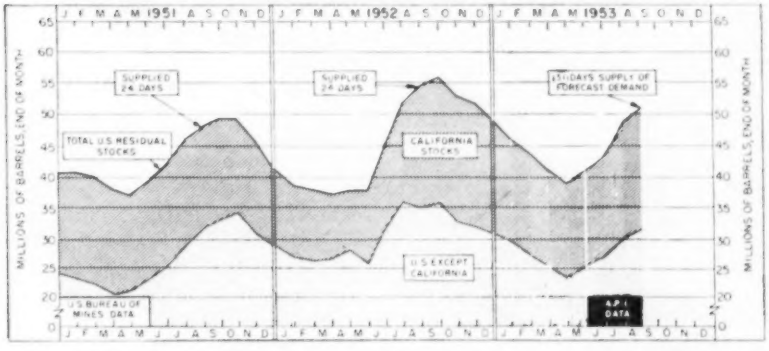
* Through Aug. 22

Total (1000 bbls.)
(Bureau of Mines Data)

7 Mos. '53*	264,835	79,673	344,508
7 Mos. '52	262,419	75,616	338,035
Change	+2,416	+4,057	+6,473
% Change	0.9	5.4	1.9

*June & July estimated from API data.

Fig. 7—Residual Stocks a Little Higher



Residual Fuels Demand

Daily Average (1000 bbls.)

Aug. '53 API*	1,435
Aug. '52 BM	1,427
Change	+8
% Change	0.6

*Through Aug. 22

Total Demand (1000 bbls.)

7 Mos. '53*	345,905
7 Mos. '52	332,384
Change	+13,521
% Change	4.1

*June & July estimated from API data

BM Data on Residual Fuels Demand, 1953

(July 30, 1953; 1000 b/d avg. by quarters)

Actual: 1st Q., 1,833 — Estimated: 2nd Q., 1,542 — Forecast: 3rd Q., 1,429 — 4th Q., 1,763

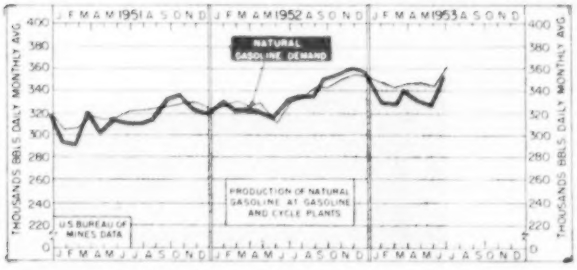
Residual Fuel Stocks

1000 bbls. end of month

	U.S. Except California	TOTAL U.S.
Aug. '53 API*	31,731	50,844
July '53 API	30,128	49,453
June '53 API	27,263	41,795
Aug. '52 BM	35,856	54,061

*Aug. 22

Fig. 8—Supply and Demand of Natural Gas Liquids



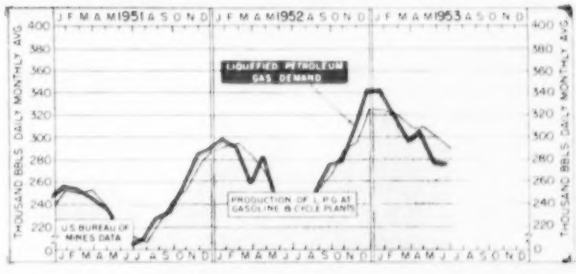
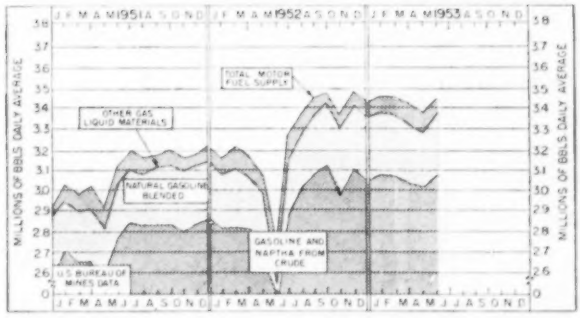


Fig. 9—Makeup of Motor Fuel Supply



(Figures in table in 1000 bbls./day average)

	Gasoline & Naphtha from Crude	Natural Blended	Other Gas Liquid Materials	Total Motor Fuel Supply
June '53	3,168	298	99	3,565
May '53	3,100	266	93	3,459
Apr. '53	3,012	270	98	3,380
June '52	2,888	281	109	3,278

Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Supply—(1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL	Demand**(1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL
June '53*	361	289	650	359	278	637
June '52	332	248	580	333	230	563
Change	+29	+41	+70	+26	+48	+74
% Change	8.7	16.5	11.9	7.7	21.0	13.1
	Total Supply (1000 bbls.)			Total Demand (1000 bbls.)		
6 Mos. '53*	62,871	56,013	118,884	61,517	55,049	116,566
6 Mos. '52	59,442	49,303	108,745	59,283	47,974	107,257
Change	+3,429	+6,710	+10,139	+2,234	+7,075	+9,309
% Change	5.7	13.6	9.3	3.7	14.7	8.6

Stocks, End of Month (1000 bbls.)

	By type of product (At gasoline plants and terminals only) LPG	Natural Gasoline	Con-densate	Finished Gasoline†	By Location Gasoline Plants	Refin-eries	Total
June '53	3,155	3,602	255	1,030	8,042	3,012	11,054
May '53	2,808	3,411	237	1,185	7,641	2,718	10,359
Apr. '53	2,161	2,940	272	1,282	6,655	2,194	8,849
June '52	2,601	2,949	240	1,042	6,832	3,203	10,035

*Supply includes receipts from refineries as well as current production from natural gasoline and cycling plants. Receipts from refineries in June included 64,000 bbls. of natural gasoline.

**Demand does not include liquefied refinery gases produced for fuel and chemical purposes, which totaled 2,625,000 bbls. in June.

†Includes naphtha and other products.

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

ACETYLENE, via the Wulff Process; Bulletin Ec-PA-0.002; The Fluor Corp. See adv't. p. 1355.

ADDITIVE, anti-oxidant for insulating oils; technical bulletin on "Ionol"; Shell Chemical Co. See adv't. p. 1371.

ADDITIVE, for fuel oils; sample and descriptive booklet on Additive No. 2; E. I. du Pont de Nemours & Co. See adv't. p. 1366.

ADDITIVE, for furnace oils; samples of and product data on "Dispersant FO"; Oronite Chemical Co. See adv't. p. 1368.

ADDITIVES, for lubricating oil; information on "Santolube"; Monsanto Chemical Co. See adv't. p. 1309.

ADDITIVES, for lubricating oils; information; Oronite Chemical Co. See adv't. p. 1282.

CATALYSTS, spherical, granular, tabletted, extruded; 8-page booklet; Harshaw Chemical Co. See adv't. p. 1365.

COMPRESSOR, 2-cycle, turbocharged, gas-engine-driven; Bulletin 130; Clark Bros. Co. pp. 1418, 1419.

CONTROL SYSTEMS; Bulletin 98097 on "Transet"; Taylor Instrument Cos. See adv't. pp. 1426-1427.

COOLING TOWER FANS; Bulletin 1503; Hartzell Propeller Fan Co. See adv't. p. 1266.

CORROSION INHIBITOR; sample of "Duomeen T Dioleate" and bulletins; Armour Chemical Division. See adv't. p. 1369.

ENTRAINMENT SEPARATORS; bulletins on purifiers for use in reactors, bubble towers, etc.; V. D. Anderson Co. See adv't. p. 1291.

EQUIPMENT CLEANING, chemical, internal and external; information and estimates; Dowell, Inc. See adv't. p. 1277.

EQUIPMENT CLEANING; handbook "What Petroleum Men Should Know to Simplify Cleaning"; Oakite Products, Inc. See adv't. p. 1430.

EQUIPMENT, light-weight, welded sheet alloy; PSC Catalog; The Pressed Steel Co. See adv't. p. 1308.

EXPANSION JOINTS; Bulletin 351; Zallea Brothers. See adv't. p. 1394.

FASTENERS, continuous-threaded stud, and nuts; answers to questions; Bethlehem Steel Co. See adv't. p. 1308.

FILTERS, for finished petroleum products, Bulletin FO-52; Warner Lewis Co. See adv't. p. 1416.

FITTINGS, seamless, welding; catalog; Globe Steel Tubes Co. See adv't. facing p. 1344.

FLAME PHOTOMETRY; how, when, where, and why it brings new profits; Data File No. 23; Beckman Instruments, Inc. See adv't. p. 1364.

FLOW METER, mercury type; Bulletin 460; The Foxboro Co. See adv't. p. 1388.

FLOW TRANSMITTERS; force balance type, d/p Cell; Bulletin 420-1; The Foxboro Co. See adv't. p. 1388.

FRACTIONATING TRAYS; "Benturi" Kaskade design; data on installations; Koch Engrg. Co. See adv't. p. 1373.

HEAT EXCHANGER TUBING, integral finned type; data sheet; Wolverine Tube Division. See adv't. p. 1392.

HEATERS, welded fintube, tank suction and line type; Bulletin 521; The Brown Fintube Co. See adv't. p. 1284.

INDICATORS, miniature; Bulletin 52-1075-223; The Hays Corp. See adv't. p. 1283.

INFRARED ANALYZERS; bulletins on pilot plant and process plant models; Perkin-Elmer Corp. See adv't. p. 1356.

INSTRUMENT CHARTS; catalog; Technical Charts, Inc. See adv't. p. 1416.

INSTRUMENT PURGE SYSTEMS, for flow or level metering; Bulletin H-11; Conoflow Corp. See adv't. p. 1420.

INSTRUMENTS, for petroleum laboratory testing; Bulletin No. 50; Refinery Supply Co. and Central Scientific Co. See adv't. p. 1428.

INSULATION, for process and steam lines; Booklet "Industrial Insulation," Phillip Carey Mfg. Co. See adv't. p. 1405.

MANOMETERS; Catalog C-12; Meriam Instrument Co. See adv't. p. 1390.

MIXERS, laboratory, portable, top and side entering; catalogs and data sheets; Mixing Equipment Co., Inc. See adv't. p. 1312.

PAINTS, rust preventative type; literature, details on a free survey; Rust-Oleum Corp. See adv't. p. 1417.

PAINTS, maintenance and rust protective; booklet on "Tygon"; U. S. Stoneware Co. See adv't. p. 1413.

PUMPS, vertical turbine type, for volatile fluids; Bulletin P-93; Johnston Pump Co. See adv't. p. 1486.

REACTORS, glass-lined, "bantam-size," 5 to 100 gals.; Bulletin 894-P-4; The Pfaudler Co. See adv't. p. 1399.

SOLVENTS; monochlorobenzene, cyclohexanol, monochlorotoluene, methyl cyclohexanol, trichlorobenzene; information; Hooker Electrochemical Co. See adv't. p. 1374.

STEAM TRAPS; Bulletin 853; W. H. Nicholson & Co. See adv't. p. 1420.

STEAM TRAPS, complete line; new 44-page book of data; Armstrong Machine Works. See adv't. pp. 1410-1411.

STEAM TRAPS, impulse type; free trial offer; Yarnall-Waring Co. See adv't. p. 1385.

STORAGE CYLINDERS, for hydrogen under pressure, multiple units; bulletin; Taylor-Wharton Iron & Steel Co. See adv't. p. 1290.

SWIVEL JOINTS; Catalog 53-C; Chiksan Co. See adv't. p. 1301.

TELEVISION, wired, for industrial use; Bulletin 1025B; Diamond Power Specialties Corp. See adv't. p. 1375.

TEMPERATURE INDICATORS, mercury-actuated; Catalog 200G; Palmer Thermometers, Inc. See adv't. p. 1360.

TUBE FITTINGS; "Swagelok" catalog; Crawford Fitting Co. See adv't. p. 1412.

TUBES, and plates, for heat exchangers; brass, copper, and alloys; Publication B-2; American Brass Co. See adv't. p. 1381.

VALVES, control; illustrated bulletin; Annin Co. See adv't. p. 1305.

VALVES, gate, alloy trimmed, alloy cast iron; Circular on No. 14477; Crane Co. See adv't. p. 1361.

the corrosion resistance of glass *plus* the working strength of steel

Pfaudler bantam-size "P" Series reactors make possible the transfer of a process from the laboratory to the pilot plant to full-scale production under parallel operating conditions. They are also widely used for processing small batches of rare or expensive products where purity is a prime consideration.

Built in standard capacities of 5, 10, 20, 30, 50, and 100 gallons, "P" Series reactors incorporate the same design features and have the same type of agitation as larger Pfaudler vessels. Depending on size, they are suitable for internal pressures from 25 to 35 p.s.i. and for jacket pressures from 75 to 110 p.s.i. Higher pressures are possible with special designs.

Glassed steel vessels for severe chemical service are built in capacities as large as 8300 gallons and are supplemented by a complete line of glassed steel pipe, fittings, and valves.

Glassed steel is resistant to *all* acids except hydrofluoric, even at elevated temperatures and pressures. With a new Pfaudler glass, it is possible to process not only with acids but also with *alkaline* solutions up to a pH of 12 and 212°F.

To give it working strength, Pfaudler glass is fused to steel in huge furnaces at temperatures of 1500-1700°F. *This high temperature firing locks the glass to the steel and makes it hard and tough.*

Write for Bulletin 894-P-6, our new general catalog on chemical processing equipment.

PFAUDLER THE PFAUDLER CO., ROCHESTER 3, N. Y.

Engineers and fabricators of corrosion resistant process equipment since 1884

Factories at: Rochester, N. Y.; Elyria, Ohio; Leven, Fife, Scotland; Schwetzingen-Baden, Germany

ADVERTISER'S INDEX

FOR INFORMATION ON ANY PRODUCT OR SERVICE ADVERTISED IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

o

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

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(A-2) Air Preheater Corp. 1297
(E-6) Allied Chemical & Dye Corp., General Chemical Div. Inside Back Cover
(A-3) American Flange & Mfg. Co. 1270
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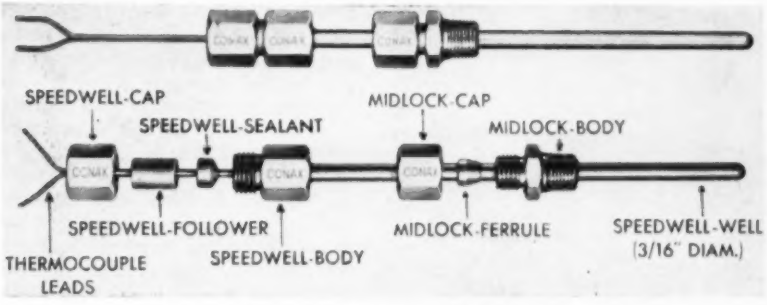
WHAT'S NEW . . .



Protector Tube Stops T/C Corrosion

The new "Conax Thermocouple Speedwell Protection Tube" eliminates junction boxes, prevents "breathing" of corrosive gases or liquids into the well, holds the thermocouple in place, and provides fast interchangeability for checking and replacing couples. Its small diameter with subsequent low mass provides greater accuracy and faster response. The complete unit is made of stainless steel with neoprene as the standard sealant. Teflon or asbestos graphite are also available as sealants. An end fitting locks and seals 20 or 24 gauge insulated duplex thermocouple in the well. The seal is effected by compressing the neoprene washer around the wires. The tube is supplied with a stainless steel, adjustable, midlock tube fitting for sealing and adjusting immersion of the protection tube into a vessel. The Speedwell protection tube is $\frac{3}{16}$ in. in diameter by 0.035 in. wall. Various lengths are available—straight or with 90° bend. End fitting is ½-in. hexagon by 1⅛ in. long. Midlock tube fitting seals and locks the well by compression of a stainless steel ferrule. It is ½-in. hexagon by 1⅛ in. long with ⅛-in. I.P.S. thread connection. Conax Corp., 4515 Main St., Buffalo 21, N. Y.

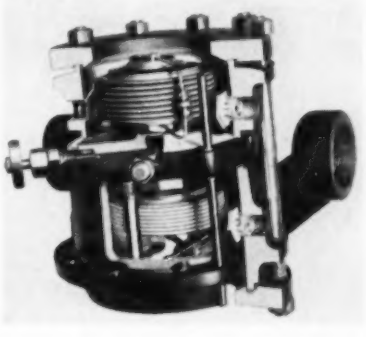
Circle No. **1** *on Reply Card*

Heat Exchanger Calculator Is Designed Like Slide Rule

. . . simplifying selection of the manufacturer's line of shell-and-tube type heat exchangers. The fibre-board unit, made up in two colors, is used to determine the square feet of surface necessary to transfer a given amount of heat between oil or water on the shell side, and water on the tube side. Operation instructions and tables of tube surface areas measured in square feet are included with the calculator, which is available, upon request through any of the heat exchanger representatives of Young Radiator Co., Racine, Wis.

For More Information

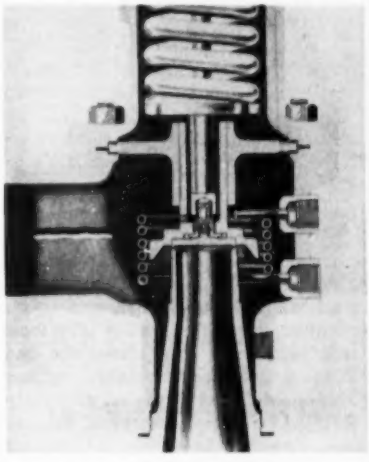
Use one of the attached reply cards to request additional details or literature on any items reviewed in "Whats New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage is required.



New Mercuryless Orifice Meter Will Operate at up to 1000 psi.

. . . working pressures, in differential ranges of 20, 50, 100, and 200 in., and ambient temperatures of —25 to 175° F. The new "Dri-Flo" unit supplements the manufacturer's regular line of mercury manometer orifice meters, Series A-70 and A-88. It is adaptable to all "American" pneumatic controllers, transmitters, differential valves, telemeters, and related instruments. Metal bellows is of one-piece stainless steel construction. Direct, full-scale recording pen movement has no external gearing or linkage multiplication. Teflon seal stuffing box is said to be nearly frictionless. Internal working parts are accessible for inspection, calibration, or cleaning by removal of one or both case heads without disturbing the manifold piping. Distortion or bellows damage due to sudden over-range is prevented by stick-proof check valves with flat synthetic seats. An additional bellows compensates for volume changes in bellows filling fluid resulting from any variation in ambient temperature. A Teflon-sealed pulsation dampener is externally adjustable under pressure. American Meter Co., 60 East 42nd St., New York 17, N. Y.

Circle No. **2** *on Reply Card*



Safety Relief Valve Design Uses Internal Heat Exchanger

. . . eliminating the need for steam tracing or jacketing where highly viscous lading might be encountered. The unit consists of a steel coil inserted into the valve body and led out to connect with a steam line. Coil ends are accessible for return-pipe installation, or one-pipe installation with a vent valve. A steam trap drains the coils and construction is suitable for back pressure use. The device is available for installation in all of the maker's nozzle and semi-nozzle valves. Farris Engrg. Corp., 533 Commercial Ave., Palisades Park, N. J.

Circle No. **3** *on Reply Card*

Grippers Handle Drums or Packages

Developed by Shell Oil Co. to cut distribution costs, a new design of gripper arms for lift trucks will grab and carry either drums or packages, providing wide versatility. Shell estimates that elimination of wooden pallets—the conventional handling method with a lift truck—would save the company between $250,000 and $750,000 a year for upkeep and replacement alone. Pallets also require freight and warehouse space and labor in manhandling.

The main force with which the Shell arms lift a load if provided by friction, uniformly distributed over a relatively large area, rather than localized pressure. This allows the handling of large loads without crushing. The effectiveness of the friction factor is raised by special shaping of the arms plus corrugated facings where they come into contact with a load. The arms are flexible and have a sufficiently firm grip to hold loads safely despite abrupt stops which, previously, caused loads to slip forward and fall.

Loads up to nearly two tons can be handled by the largest type of attachment grippers. That type handles four 55-gal. drums or the equal in cases, quarter-drums, kegs, or pails.

Development of the arms started several years ago as a project of Shell's marketing operations department. Elwell-Parker Electric Co. of Cleveland constructed the attachment, through several phases, under Shell's guidance. The study began when Shell concluded that palletless handling was preferable. Early tests showed that existing gripper arm devices were unsatisfactory for several reasons. Not only did they have to be changed for different types of loads, but the thickness of the arms necessitated leaving large gaps between stored loads, thereby wasting warehouse and freight space.

The new attachments are expected to be on the market for general use within several months. They will be produced by manufacturers licensed by the oil company. Shell Oil Co., 50 West 50th St., New York 20, N. Y.

Circle No. **4** *on Reply Card*

Magnetic Tank Gages Have Stainless Steel Head Plates

. . . and other features designed for long service under severe conditions. Built for use on LPG and ammonia tanks, "Criterion 3190" liquid level gages are said to be suitable for use in mobile tanks and other places where rough treatment is expected. A snap-on dial chamber is held in place by a circular spring which fits into a recess in the head plate. Proper positioning of the chamber is insured by a key and groove arrangement. No tools are needed for removing or replacing dial chambers. Float is steel, with reinforced joints, silver-soldered for LPG service and soft-soldered for ammonia applications. Floats are pretested for leakage and withstand 600 to 900 psi. Rod and counterweight assembly have been designed so counterweight can hug the centershaft support member. This is said to make installation in a compact head easier while still providing proper buoyant force when the float rod hangs down in an empty position. Rochester Mfg. Co., 203 Rochwood St., Rochester 10, N. Y.

Circle No. **5** *on Reply Card*

New Instrument Will Record Three Variables at 20 Points

. . . by use of a newly-designed switching unit. It can be adapted for use with any physical quantity for which a sensing element can provide an electrical output. Some of the variables which can be measured are liquid flow, liquid level, displacement, current, power, strain, humidity. Units can be set to different combinations of manual or automatic operation. They can be set to record from one to three variables and can be adapted to record as many as 60 variables. Time necessary to sample and record all 60 measurements is approximately two minutes. As values being measured are printed on recorder, symbols are automatically printed to identify the variable being measured and the point of measurement. The switching unit can be set to record the three variables at one point and then switch automatically to the next position. It can also be set to record in sequence any one of the variables at each of the 20 positions, or to record the three variables at one position. Hastings Instrument Co., Hampton, Va.

Circle No. **6** *on Reply Card*

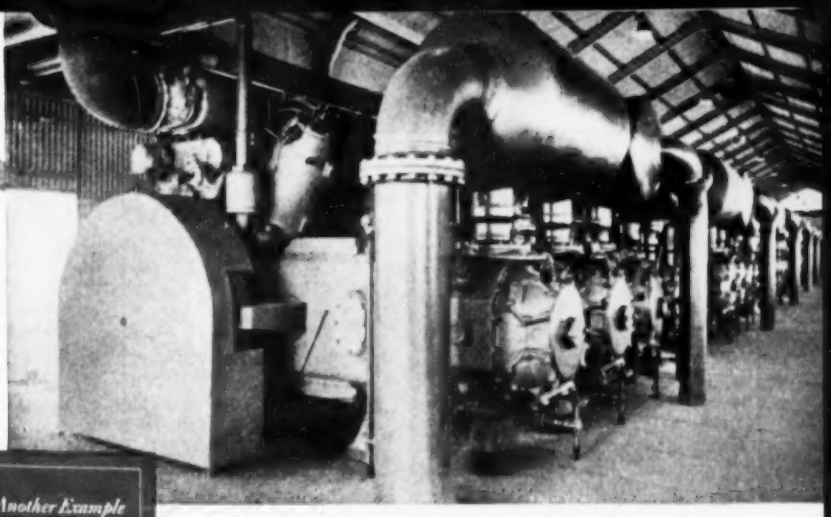
FOR PROCESS COMPRESSING

AT THE DIAMOND "M"-SHARON RIDGE GASOLINE PLANT

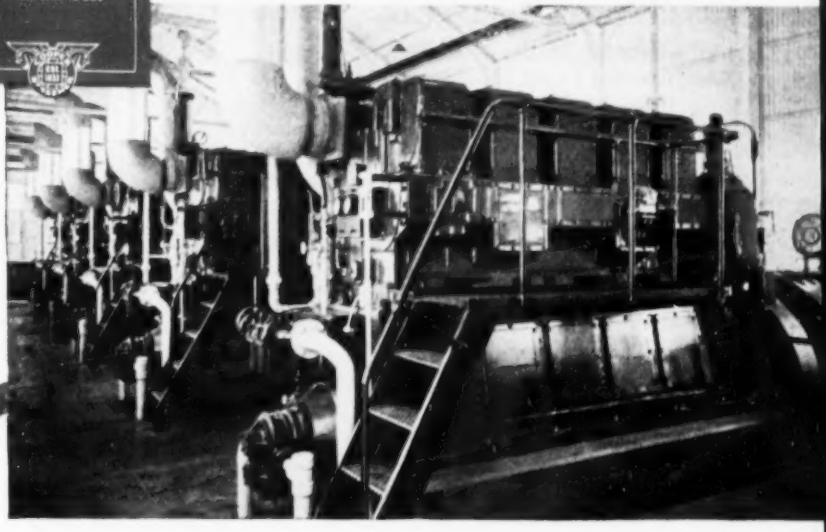
SCURRY COUNTY, TEXAS

16,080 Cooper-Bessemer horsepower

Another Example of Efficient Power at Lower Cost



Above: Some of the Cooper-Bessemer GMV's, now totaling 13,200 compressor horsepower, in the Diamond "M" — Sharon Ridge Gasoline Plant, Scurry County, Texas. Below: In this same plant 6 long-lived Cooper-Bessemer 375 horsepower gas engines drive generators for all electrical power requirements.



FOR ELECTRIC GENERATION

• As shown opposite, modern Cooper-Bessemers team up to meet over-all power requirements at the Diamond "M"—Sharon Ridge Gasoline Plant, Scurry County, Texas. This plant now has twelve 1100 HP GMV's, each equipped with three compressor cylinders for 3-stage compression to 525 psi.

The companies participating in the Diamond "M" have had broad experience with GMV qualities—in other gasoline plants, in major chemical plants and *wherever* large scale compressing demands continuous, low-cost performance. That's one reason—experience—why GMV's were picked for this jointly owned operation.

If your plans call for compressor service, power generation or both, check with the nearest Cooper-Bessemer office on modern units that will keep your costs at a minimum.

COOPER-BESSEMER

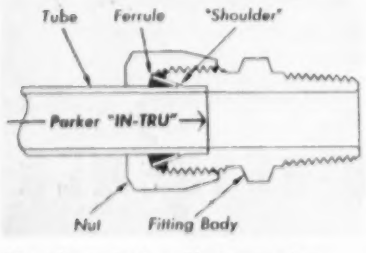
MOUNT VERNON, OHIO — PLANTS — GROVE CITY, PENNA.
New York • Chicago • Washington • San Francisco • Los Angeles • San Diego • Houston • Dallas • Odessa • Pampa • Greggton • Seattle • Tulsa • St. Louis • Gloucester • New Orleans • Shreveport
Cooper-Bessemer of Canada, Ltd., Edmonton, Canada

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS • HIGH PRESSURE LIQUID PUMPS

Pump or Pipe Lining Process Designed for Exact Tolerances

. . . by a special molding technique during the curing treatment. Useful for neoprene, soft or hard natural rubber, or other compounds, it eliminates flow obstructions caused by the raised "rims" of ordinary coatings on the inner surfaces where joints are made. After sandblasting, the equipment to be lined is treated with a priming solution and then coated with tie cement. A tube of the coating compound is then inserted and adhered under pressure against the prepared inner surface. When flange ends are to be covered, steel molds set at a predetermined thickness are inserted and bolted firmly to flanges. An 8-hr. vulcanizing treatment follows which accomplishes molding in addition to curing the coating compound. As a result, no grinding is necessary to meet thickness tolerance or for reshaping. Goodall Rubber Co. of Texas, Houston, Texas.

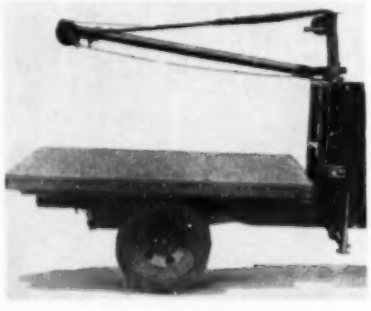
Circle No. **7** *on Reply Card*



Flareless Tube Fittings Line Designed for Instrumentation

. . . and fast assembly. The "In-Tru" design is a three-part construction consisting of the connector or fitting body, the nut, and the ferrule or sleeve. Fittings require no soldering or welding of the joints, no special tools beyond a wrench to tighten the fitting nut. The way it works is as follows: After the tube is seated, the nut is tightened. This exerts a wedging force on the ferrule, which in turn "bites" into the outer surface of the tube, forming a "shoulder." Because the cutting edge of the ferrule is exposed, the extent of bite into the tube is readily visible if the joint is disconnected for inspection. After an inspection, the fitting is reassembled by hand until the ferrule is seated. An additional ⅙ to ⅓ turn of the nut completes the assembly. Complete line includes: male and female connectors, unions, male and female elbows, male and female run and outlet tees, union tees and crosses, nuts, ferrules, and tube end reducers. Standard fittings are brass, for copper tube O.D.'s from ¼ to 1 in. Aluminum for use with aluminum tubing is available on special order. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

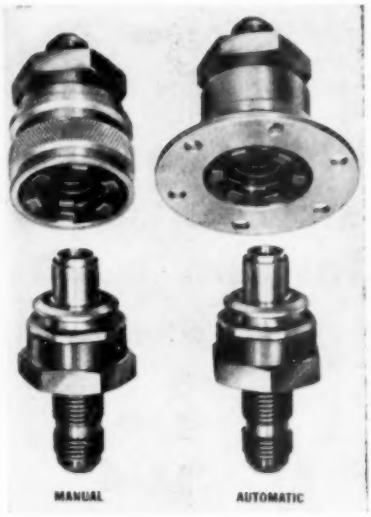
Circle No. **8** *on Reply Card*



Self-loading Truck Crane Will Speed Material Handling Jobs

. . . in capacity range from ½ to 2-ton lifts. The crane unit mounts directly behind the truck cab and occupies only from 16 to 18 in. of space. There is no reduction in truck body or platform capacity. Installation requires no cutting or alterations in the truck body. Two models are being manufactured: one with an elevating mast and one with a "fold-over" superstructure. In the latter, the top portion can be folded down for traveling and for bridge and door clearance. Standard loaders will pick up loads from any radius up to 16 ft. On the "fold-over" models, the boom swings 170°; on the elevating mast models, it swings a full 360°. Power for hoisting is supplied by the truck engine through a power take-off. Winch employs standard parts. Ray-Lind Mfg. Co., Iron River, Mich.

Circle No. **9** *on Reply Card*



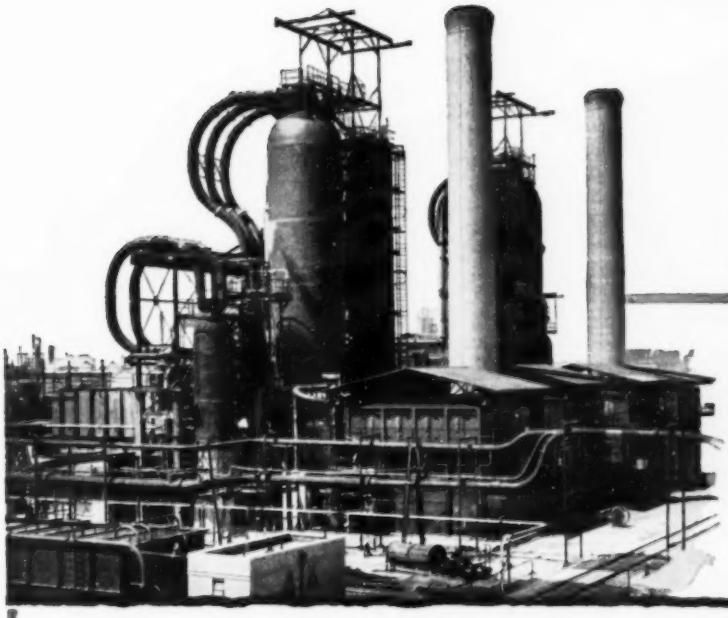
Hydraulic Coupling Is "Quick Disconnect" at Full Pressure

. . . with safe and positive action. The new "Inst-o-matic" coupling comes in two models. The manually-operated model can be disconnected with a "pull," and connected with a "push-pull." The automatic model can be set to disconnect automatically at any desired load weight, or it can be set to disconnect at a predetermined system pressure. Both models are adaptable in favor of either weight or flow. Where pressure drop is a problem, larger couplings can be used on smaller tube lines; for instance, a ¾-in. coupling can be used on a ¼-in. tube. Where weight is the main factor, smaller couplings can be used. The coupling was designed with weight savings as a criterion. Valves are always open when the coupling is connected; they cannot be closed when coupled. And conversely, valves are always closed when coupling is disconnected. Standard type connections are furnished with the Inst-o-matic. E. B. Wiggins Oil Tool Co., 3424 East Olympic Blvd., Los Angeles 23, Calif.

Circle No. **10** *on Reply Card*

Dehumidifier Has Self-adjusting Nozzle, Non-Clogging Aspirator

. . . which stabilizes unit operation during variable air pressures and volumes for constant removal of injurious liquids, solids and vaporous contaminants. 'Vi-Speed," a self-cleaning device, purifies compressed air and reduces humidity to a low dew point. Baffle surfaces in the unit have been enlarged and re-positioned over previous models for greater ex-



Carey INSULATION is at work for GULF . . .

keeping process and steam lines operating at lowest cost

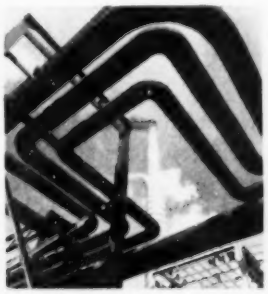
Refinery men demand *quality* insulation for processing operations. It's needed to keep fluids at constant temperatures. Helps cut fuel waste.

Since 1929, Carey insulation nas been in continuous service at the Port Arthur, Texas plant of the Gulf Oil Corporation. Over the years, it has proven itself equal to the punishing strains of vibration and rapid expansion and contraction of equipment encountered in refinery operations . . . while guarding against heat loss, holding the line on costs!

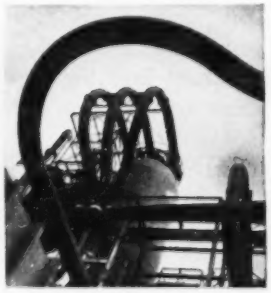
In *your* plant, you'll find dozens of applications where a Carey insulation material can conserve heat, save fuel. Carey's complete line of high and low temperature insulations includes blocks, blankets, pipe wrapping and jackets, cements and new Super-Light 85% magnesia in precision-sized blocks and nesting "O.D." pipe coverings that are easy and economical to apply.

Whether your problem is one of insulating "straight runs" or complicated shapes, a Carey Industrial Sales Engineer can show you why Carey insulation is best for the job. He'll gladly furnish you with complete technical and application data. No obligation to you. Telephone, wire or write our nearest office today.

Another Carey product—Careystone Corrugated Asbestos-Cement Roofing and Siding—protects Gulf Oil Corporation's warehouse at Port Arthur, Texas. This material is absolutely impervious to corrosion, rust, rot, decay; never requires painting or preservative treatment; virtually maintenance-free!



"Worm's eye" view of live and exhaust steam lines insulated with Carey materials. Besides the usual hazards of expansion, contraction and vibration, this Carey installation stands up under the extremely hot, humid weather of the Gulf area.



Carey insulation materials have weathered 23 years of continuous service on the fractionating tower and vapor lines of these atmospheric and vacuum stills at Gulf Oil Corporation's Port Arthur, Texas plant.

Write Today for Your FREE Copy

of "Industrial Insulation." Tells all about Carey insulations, and how to select and use them. A copy is yours for the asking.

*DEPT. PE-9

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A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

One Sure Way to Get MORE DEFENSE FOR LESS MONEY

How can we get more national defense for less money? The best answer yet given to this question appears in a little-noticed section of the new defense budget. That answer, with which this editorial is concerned, is to provide more equipment with which to step up munitions production in an emergency. Thus we can eliminate much of the need to stockpile finished munitions in advance.

The new defense budget provides an appropriation of $500 million, to be invested by the Secretary of Defense in specialized facilities required to produce munitions on a wartime scale, but not adapted to profitable operation by private industry in normal times. Facilities of this type are known as "stand-by capacity."

There is no strictly political controversy over the "stand-by capacity" program. It was originally suggested by Clay Bedford, Special Assistant to the Secretary of Defense during the Truman administration. It has since been reviewed and endorsed by the Eisenhower administration. Moreover, it involves little or no technical controversy. Civilian and military experts are well agreed that the only alternative to enormous expenditures for stockpiling military equipment is to provide enough facilities for producing it quickly in an emergency.

Here is the Key Idea

In his speech of May 19, introducing his defense budget to Congress and the nation, President Eisenhower stressed the value of such reserve capacity in these terms, ***"The more swiftly and smoothly we can mobilize, the less our dependence upon costly standing armies and navies."***

In accord with this idea, the $500 million requested for the present reserve capacity program would be invested in tools that require a long time to produce, and so present grave complications in an emergency unless they are ready in advance. Some such tools would be installed in new plants that are needed to eliminate potential bottlenecks in the defense production program. Others would be ordered to replace that part of the government's present machine-tool inventory which is made obsolete by changes in the design of defense products. By completely "tooling up" with the most modern equipment, the admin-

istration hopes to realize a production potential many times greater than could be achieved by spending the same amount of money on military end-products.

Examples of Savings

In the specialized field of defense production, adequate modern capacity is the key to both economy and speedy delivery in a pinch. Here are some striking examples from the recent report of the Advisory Committee on Production Equipment (Vance Committee) to the Director of Defense Mobilization:*

—In the case of certain ammunition components, the cost of new capacity can be recovered in only six weeks of full production.

—If $500 million worth of special tools needed to make aircraft are purchased in advance, aircraft production during the first two years of war will be increased about $18 billion. In other words, it costs 1/36 as much to acquire the tools in advance as to acquire the aircraft.

—In the case of a certain ordnance item, an expenditure equal to the cost of only 150 units of the item will provide the capacity to produce thousands and save three years' time in meeting mobilization requirements.

Moreover, reserve plants and equipment can be kept up-to-date at only a small fraction of the cost required to maintain an up-to-date reserve of military end-products. The cost of replacing 5,000 obsolete tanks is at least $1 billion. The cost of new tools for a tank plant would be less than 10% of that amount.

*This Committee, headed by Mr. Harold Vance, President of the Studebaker Corporation, included Clay Bedford, then President of Chase Aircraft, Manly Fleischman, former Defense Production Administrator, and several retired military leaders with wide experience in procurement.

Savings Will Multiply

On the basis of facts like these, the Vance Committee recommended that the Defense Department spend $500 million to $800 million per year on specialized defense production facilities in order to provide substantial reserve capacity as soon as possible. It also recommended that expenditures for military end-products which get obsolete rapidly be held to a minimum. The Eisenhower administration has adopted this approach to the problem of munitions production in asking that $500 million be invested in reserve capacity.

The importance of this approach is much greater than is indicated by the amount of money to be spent on new tools, although this amount will go far toward assuring a healthy machine tool industry, adequate to meet emergency demands. ***What is really important is the great saving that can eventually be made in the cost of our defense program by a modern tooling program.*** If we are to maintain this program for a long period, and if we are to pay as we go, we must have a low-cost program. No other plan to reduce and control the cost of a garrison economy can compare with the new approach suggested in the Vance Report and now embodied in the new defense budget.

Congressmen will do well to scrutinize all military appropriations carefully. They have a chronic tendency to be too big. But there should be no penny-pinching on investments in capital equipment that will pay out in as short a time as six weeks in a war emergency. It would be tragic if this opportunity for real economy were lost in the controversy over other aspects of the defense program. ***The tooling program is a key part of the Eisenhower effort to cut defense costs. It should be promptly approved.***

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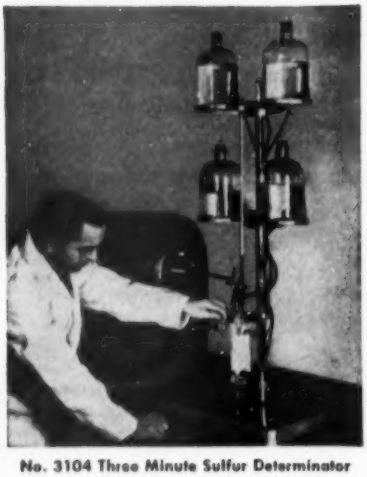
PRACTICAL SULFUR ANALYSIS

Accurate Results in 3 MINUTES with the

DIETERT-DETROIT SULFUR DETERMINATOR



No. 3104 Three Minute Sulfur Determinator

The Dietert-Detroit Sulfur Determinator used with the Varitemp or Hitemp Combustion Furnace provides the most practical means of getting results in a few minutes with accuracy equal to or better than any other method.

APPLICATIONS	FEATURES
Metals and Ores	Lowest First Cost
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Let our chemists suggest a complete ready-to-go set-up to solve your sulfur analysis problems.

CONTROL EQUIPMENT
HARRY W. DIETERT COMPANY
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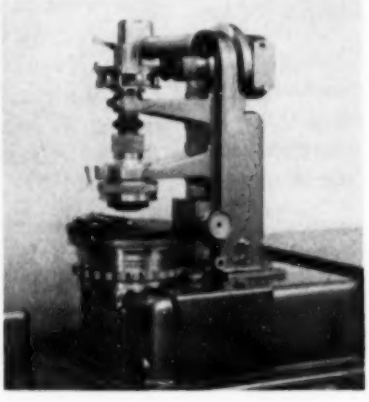
posure of contaminants to drying agent action and for larger area for separation of heavy impurities and better accommodations of momentary overloads. The manufacturer's drying agent, "Dryolite," is said to cover a wide range of line temperatures from 100° F. to below freezing. Van Products Co., 3789 West 12th St., Erie 2, Pa.

Circle No. **11** *on Reply Card*

New Spray Type Insulation for Metal Withstands up to 5000° F

. . . and will adhere directly to clean surfaces without sandblasting or use of primer preparations. Called "Pyrolock," a 1/16-in. coating protects metal for as long as ten seconds against flame temperatures hotter than the melting point of metals. Described by the manufacturer as a water base inorganic material, it was developed originally at the request of the Defense Dept. for use in the rocket and guided missile field. A dried layer of Pyrolock bonds with a strength that withstands sharp impacts short of actual deformation of the base metal. Resistant to most solvents and chemicals, the material also can withstand indefinite temperature cycling from —60 to 165° F. B. F. Goodrich Co., Industrial Products Division, Akron, Ohio.

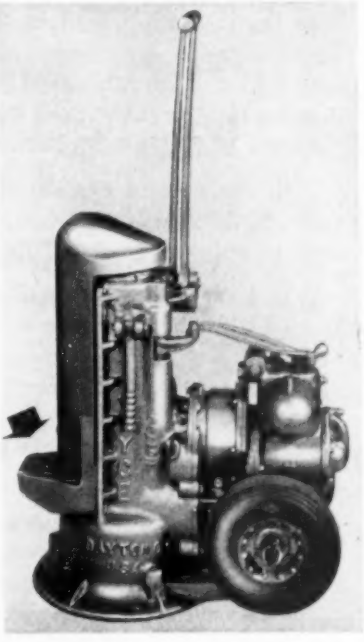
Circle No. **12** *on Reply Card*



Microscope Unit for Infrared Spectrometers Aids Research

. . . by providing infrared spectra of a single crystal, a single fiber or microscopic tissues. With its use, spectra have been obtained on single textile fibers less than 17 microns in diameter. The unit will attach directly to any Perkin-Elmer single beam infrared spectrometer. The optical system is made up entirely of reflecting elements, so that it is free of chromatic aberration. It is equipped with a coarse and fine focussing adjustment for positioning the sample and with an adjustable diaphragm which restricts the field of view precisely to the area covered by the sample. The optical path may be flushed with dry nitrogen to reduce the carbon dioxide and water vapor adsorption bands on the infrared spectra. The microscope is so designed that only radiation that has passed through the sample reaches the thermocouple. A complete spectrum can be recorded in about 20 minutes. The Perkin-Elmer Corp., Norwalk, Conn.

Circle No. **13** *on Reply Card*

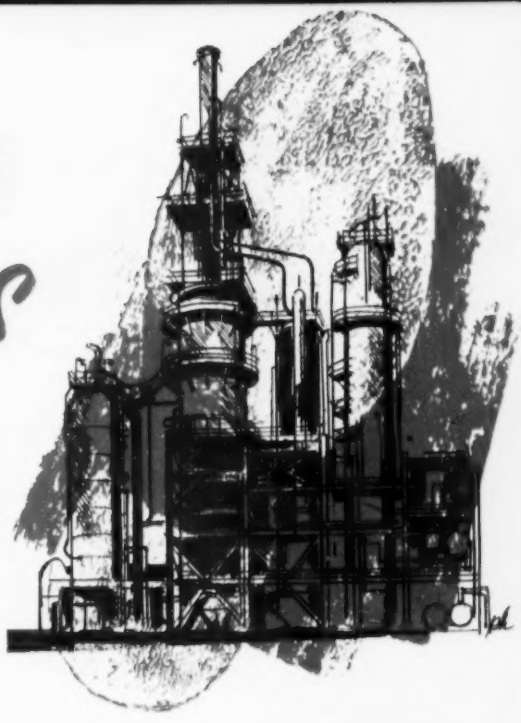


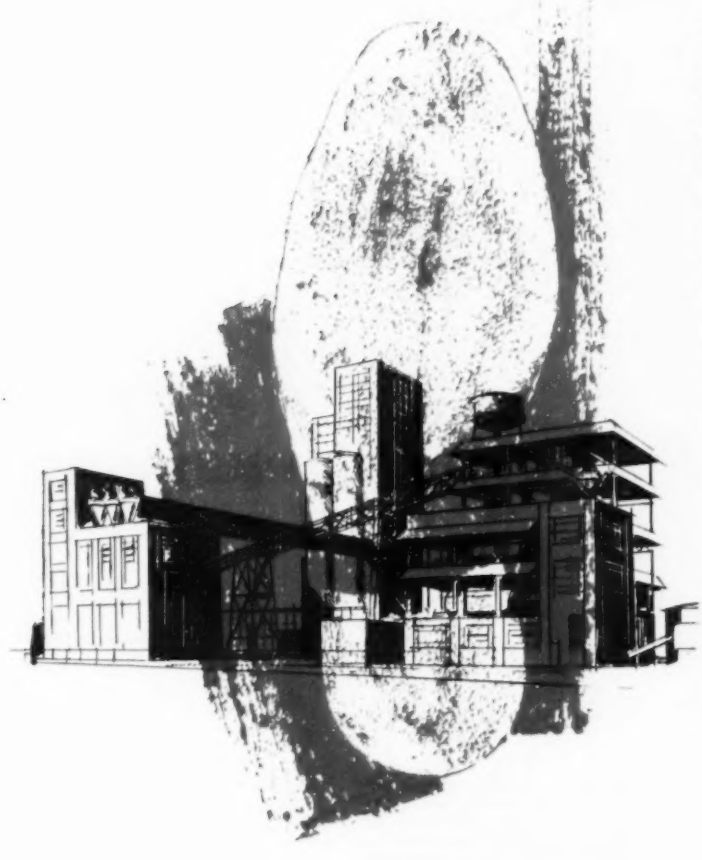
Air Motor Operated Jack with Toe-Lift Handles 75-ton Loads

. . . from 9-in. to 13¾-in. height above floor. The toe-lift attachment can be quickly removed and the jack will lift 100 tons on top of its ram. The jack is a ball-bearing geared screw type, powered by a 5 hp., multi-vane Ingersoll-Rand, heavy duty, rotary air motor. It has an automatic shut-off at both upper and lower limits of the ram. Unit is easily portable, with a long trundling handle, and large, roller-bearing, semi-pneumatic tired wheels. Company's present 100-ton jacks can have the toe-lift feature added at any time without altering the jack. Joyce-Cridland Co., Dayton, Ohio.

Circle No. **14** *on Reply Card*

BLAW-KNOX HAS MADE *GREAT STRIDES* IN BOTH CHEMICAL AND PETROCHEMICAL PROJECT DEVELOPMENT





Time was when Blaw-Knox Company was noted chiefly for its outstanding work in the Chemical and Processing fields. Today, however, Blaw-Knox Chemical Plants Division can look back on the pioneering role it played in the young petrochemical industry! Much of this work was "unorthodox" but not speculative. In every instance, the client came to us with a problem he wanted solved. We engineered an economical solution, and built a successful plant. We welcome the opportunity to put this experience behind any project you may be contemplating.

PLANTS & PROCESSES

Catalytic Reforming • Catalytic Cracking • Decarbonizing • Waste Disposal • Crude Distillation • Ethylene Oxide • Fischer-Tropsch Oxo • Caustic Soda & Chlorine • Extraction • Fractionation • Package Gasoline Stripping • Recycling • Alkylation • Resin Polymerization • Tonnage Oxygen • Synthetic Fuels

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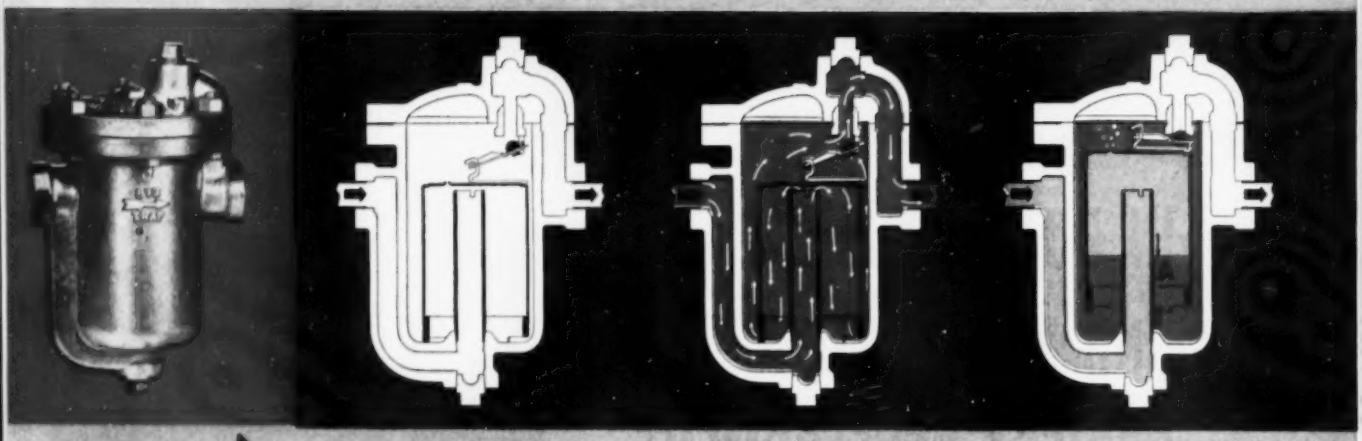
ARMSTRONG TRAPS are



A WORKING PICTURE OF ARMSTRONG DESIGN

1. When trap is first installed, the inverted bucket is down and the valve is wide open.

2. When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until . . .

3. steam (light color) reaching the trap floats the inverted bucket and closes the valve.

THE highly efficient design of modern Armstrong traps directly reflects over 40 years' experience in inverted bucket trap manufacture and application gained since Armstrong developed the first practical inverted bucket trap in 1911.

Armstrong design offers:

- A "frictionless" leverage system which combines high leverage with wide opening of a large orifice.
- A minimum of parts.
- Strong, corrosion-resistant and wear-resistant materials.
- Generous margins of safety.

For trap users this means:

- Large capacity.
- Dependable service under adverse operating conditions.
- Low maintenance.
- Continuous operation of heating and process equipment.

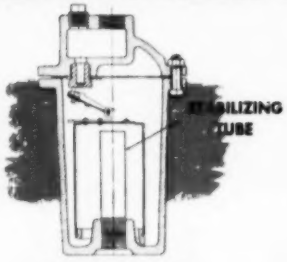
The soundness and benefits of Armstrong design have been proved in thousands and thousands of plants all over the world. To insure dependable condensate drainage for a new plant or plant expansion, simply specify: "Traps shall be Armstrong." For additional information, call your local Armstrong Representative or write:

ARMSTRONG MACHINE WORKS
826 Maple St., Three Rivers, Michigan

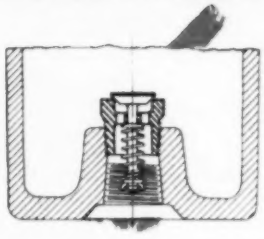
SELF-SCRUBBING ACTION (see Fig. 2 above). Note that condensate first flows down *between bottom of bucket and trap body*, then up and out through orifice. The high velocity flow under bottom of bucket keeps dirt in suspension, washes it out when trap opens. No dirt problems with Armstrong design.

BUCKET FLOATS WHEN LESS THAN ⅗ FULL OF STEAM (see Fig. 3 above). The generous margin of safety (dimension A in Fig. 3 above) insures that the bucket will float with trap body partly full of water. A heavier bucket would give more power but it might not float and close the valve.

SOME OTHER ARMSTRONG



STABILIZING TUBE
Condensate, air and steam are admitted above water level in trap bucket. The water level is undisturbed, eliminating wear-producing agitation of the bucket, valve lever and valve. This exclusive feature greatly lengthens life of working parts.

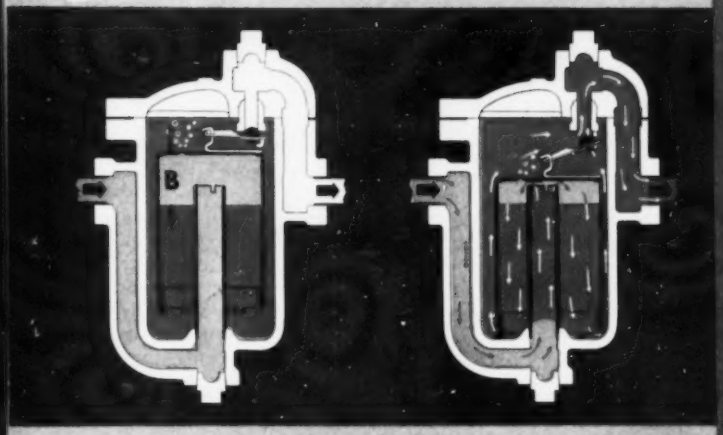


INTERNAL CHECK VALVE
All Armstrong traps can be equipped with the Armstrong spring-loaded stainless steel check valve. Costing less than an external check valve, it also saves installation labor and fittings.

ARMSTRONG · INVERTED BUCKET · STEAM TRAP

ARMSTRONG

Designed to give better Performance!

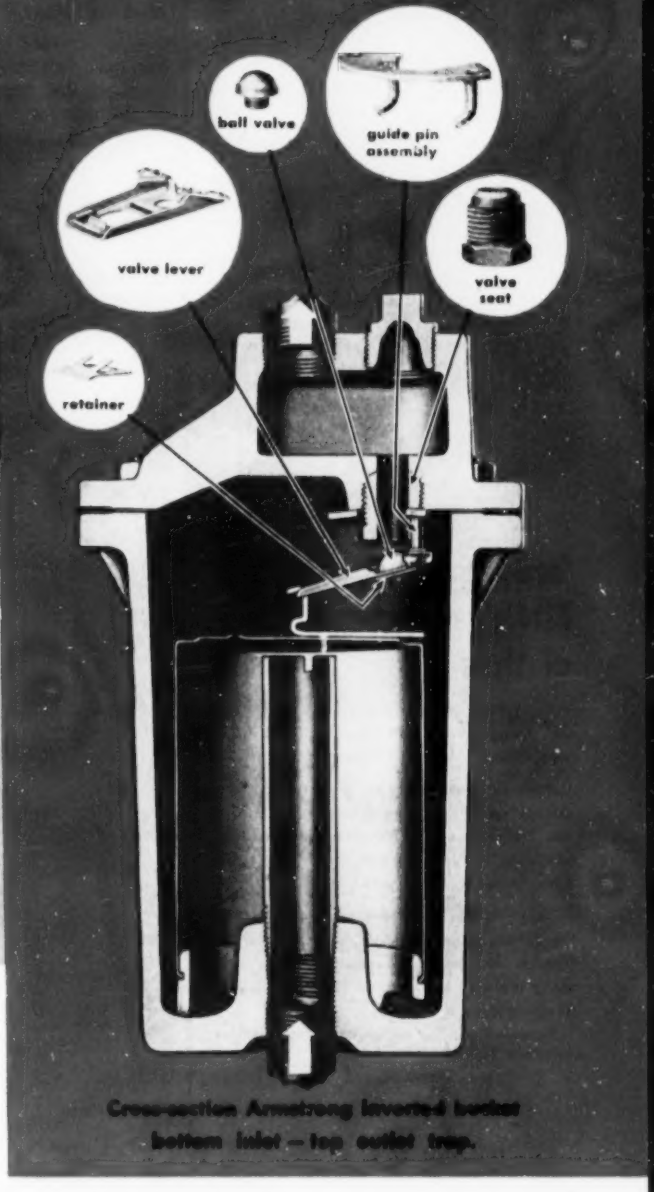


4. When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

5. When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

NO AIR BINDING (see Fig. 4 above). Air mixed with steam passes through the bucket vent, collects at top of trap and is discharged ahead of condensate. The large air-handling capacity of Armstrong traps insures top equipment temperatures and faster heat-up.

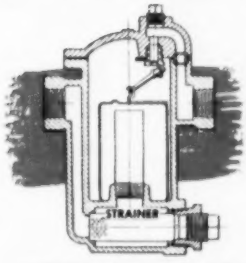
EXCESS POWER PROVIDED FOR OPENING TRAP (see Fig. 5 above). Weight of bucket times leverage opens trap. Here again Armstrong design provides a generous safety margin. Reducing dimension B in Fig. 4 would increase power of bucket but margin between test opening pressure and operating pressure would be too low to allow for normal wear and for pressure fluctuations.



Cross-section Armstrong Inverted bucket bottom inlet – top outlet trap.

TRAP DESIGN FEATURES

THERMIC VENT BUCKET
Where large amounts of air must be discharged when steam is turned on, and where air can be pushed out ahead of incoming steam, this bucket will speed heat-up greatly. The vent is open when trap is cold, closes at 210° F. Has 50 to 100 times air handling capacity of standard buckets.

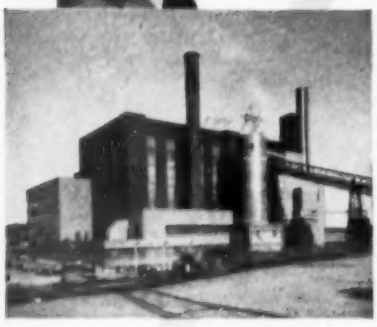


INTEGRAL STRAINER TRAPS
The two smallest sizes of Armstrong traps, most apt to need strainer protection, are available in a body style having the strainer built right in. The strainer can be cleaned while trap is operating.

SEND FOR *NEW*
44-PAGE STEAM TRAP BOOK

Complete data on Armstrong trap design and operation; physical data and list prices; capacities; selection, installation and maintenance recommendations. Free on request.

STEAM TRAPS



Schiller Station
Portsmouth, N. H.
Public Service Company of New Hampshire

"We've found that 'soaping' Swagelok Tube Fittings is just a waste of time . . ."

The power plant pictured above is equipped with Swagelok Tube Fittings installed by Midwest Piping & Supply Company, Inc.

Midwest Superintendent Moran says, "We always 'soap' each joint after original installation. Testing Swagelok Fittings revealed no leaks whatever. We've found that 'soaping' Swagelok Tube Fittings is just a waste of time . . ."

Here's further impressive proof that Swagelok Fittings are leakproof . . . on Ultra-High Vacuum applications, Swagelok Fittings commonly are used in the range of 10^{-7} millimeters of mercury.

Swagelok catalog on request. Address Department 662.

Swagelok®

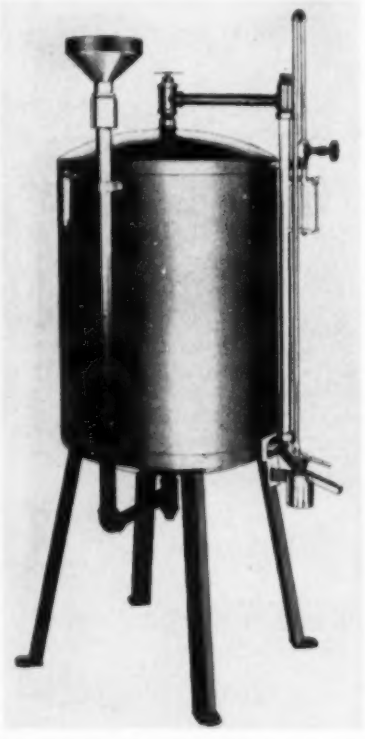
TUBE FITTINGS AVAILABLE IN:
BRASS, ALUMINUM, STEEL, STAINLESS STEEL, MONEL

CRAWFORD FITTING CO.
884 East 140th Street Cleveland 10, Ohio
Teletype CV-785

New Thickening Agent Aid in Making Multi-purpose Greases

. . . because of its strong, needle-like particle structure. "Permagel" is an inorganic, purified colloidal form of the mineral attapulgite. It is said to yield lubricating greases with such qualities as: low temperature pumpability, no melting or dropping points, excellent physical stability and mechanical stability, good water washing resistance, effective corrosion resistance, and high bearing performance. Attapulgus Minerals & Chemicals Corp., 210 West Washington Square, Philadelphia 3, Pa.

Circle No. **15** *on Reply Card*



Gravity Feeder Will Maintain A Constant Liquid Flow Rate

. . . regardless of level variations in the main tank. Flow rate of the "Liquifeeder" is governed by a valve which meters the air admitted to the supply tank. While there are no valves or orifices in the flow line, rate can be varied from less than ½ pint/day to more than 500 gal/day. Unit is equipped with a combination sight glass and bubble type flow meter. Construction materials are varied to suit specific liquid requirements. Parts subject to corrosion are made of stainless steel with Teflon gasketing. Tank sizes are from one quart to hundreds of gallons. Hankison Corp., 236 Biltmore Bldg., 951 Banksville Rd., Pittsburgh 16, Penna.

Circle No. **16** *on Reply Card*

Gas Alarm Samples Potential Explosive Atmospheres

. . . sequentially from six separate locations. "Model RV-6" draws samples continuously through metallic tubing and analyzes them point by point on a 30-second cycle. Detecting instrument is a platinum filament Wheatstone Bridge detection circuit. Indication of the presence of combustible gas is provided on a panel-mounted indicating instrument, while the sample line currently being analyzed is indicated by a series of pilot lights on the front panel. Model variations are available to permit sampling from any number of locations from two to eight. The apparatus is equipped to draw continuous samples through all lines in the system so sequential analysis is always performed on fresh samples. Dimensions of the steel cabinet housing the unit are 22 in. wide, 18 in. deep and 68 in. high. Operation is from 115 volts AC, 50-60 cycles. Johnson-Williams, Ltd., 2686 Third St., Palo Alto, Calif.

Circle No. **17** *on Reply Card*

Trade Literature

Automatic Plant Operations

. . . consultation, analysis, design and construction; a package plan being offered by the company to management; claimed to be the first service of its kind in the automatic control field; in 8-page bulletin entitled "A Proposal for Managements with Vision." CDC Control Services, Inc., 400 S. Warminster Rd., Hatboro, Pa.

Circle No. **18** *on Reply Card*

Portable pH Meters

. . . for research and field applications; performance characteristics and pictures in 4-page *Bulletin* 322-23 distinguish the four units in the series. Beckman Instruments, Inc., South Pasadena 1, Calif.

Circle No. **19** *on Reply Card*

Density, Level Determination

. . . with radioactive substances; 4-page *Bulletin DE-753* tells what the "Densitron" does and how it is operated. Instruments, Inc., 122 N. Madison, Tulsa, Okla.

Circle No. **20** *on Reply Card*

Try the "NO-RUST TWINS"

the quickest "paint" solution to corrosion, yet!

The "no-rust twins" bring a smile to the face of the most hardboiled maintenance engineer— for they give him two powerful weapons in his battle for lower cost maintenance painting.

TYGORUST — a new primer that cuts surface preparation costs in half. Goes over *wet* or dry rusted steel with no more surface preparation than wire brushing loose rust and scale. Goes over old paint coatings, too. Dries within minutes. Stops and inhibits rust formation.

. . . And forms the perfect primer for Tygon vinyl top-coats.

TYGON PAINT has been thoroughly proved during the past 15 years in hundreds of the toughest applications: in chemical plants, in metal finishing plants, in oil refineries, in pulp and paper mills — wherever fume corrosion has been a problem. This top-quality vinyl coating outlasts, outwears, outperforms conventional coatings two to one.

Put the two together — TYGORUST and TYGON PAINT — and maintenance painting costs, per foot—per year, hit a new low.

108-Q

WRITE FOR THIS BOOKLET TODAY!

Tells you just what you can expect from Tygon Paint and Tygorust under the corrosive conditions that exist in your plant. Free on request. Address Plastics & Synthetics Division, The U. S. Stoneware Co., Akron 9, Ohio.

U. S. STONEWARE

Akron 9, Ohio

ECONOMICAL answers to industrial problems—a few of which are shown on these pages—call for specialized *facilities* and years of *experience*.

Here at Alco you will find a large measure of both. You will find experience gained through many years of designing and fabricating heavy metal equipment for petroleum, chemical, power and manufacturing companies all over the world.

You will find modern equipment and machines, many of them designed and built by Alco, capable of meeting almost every conceivable type of metal-fabricating requirement—facilities operated by skilled craftsmen, and applied by designers and engineers fully aware of industry's needs.

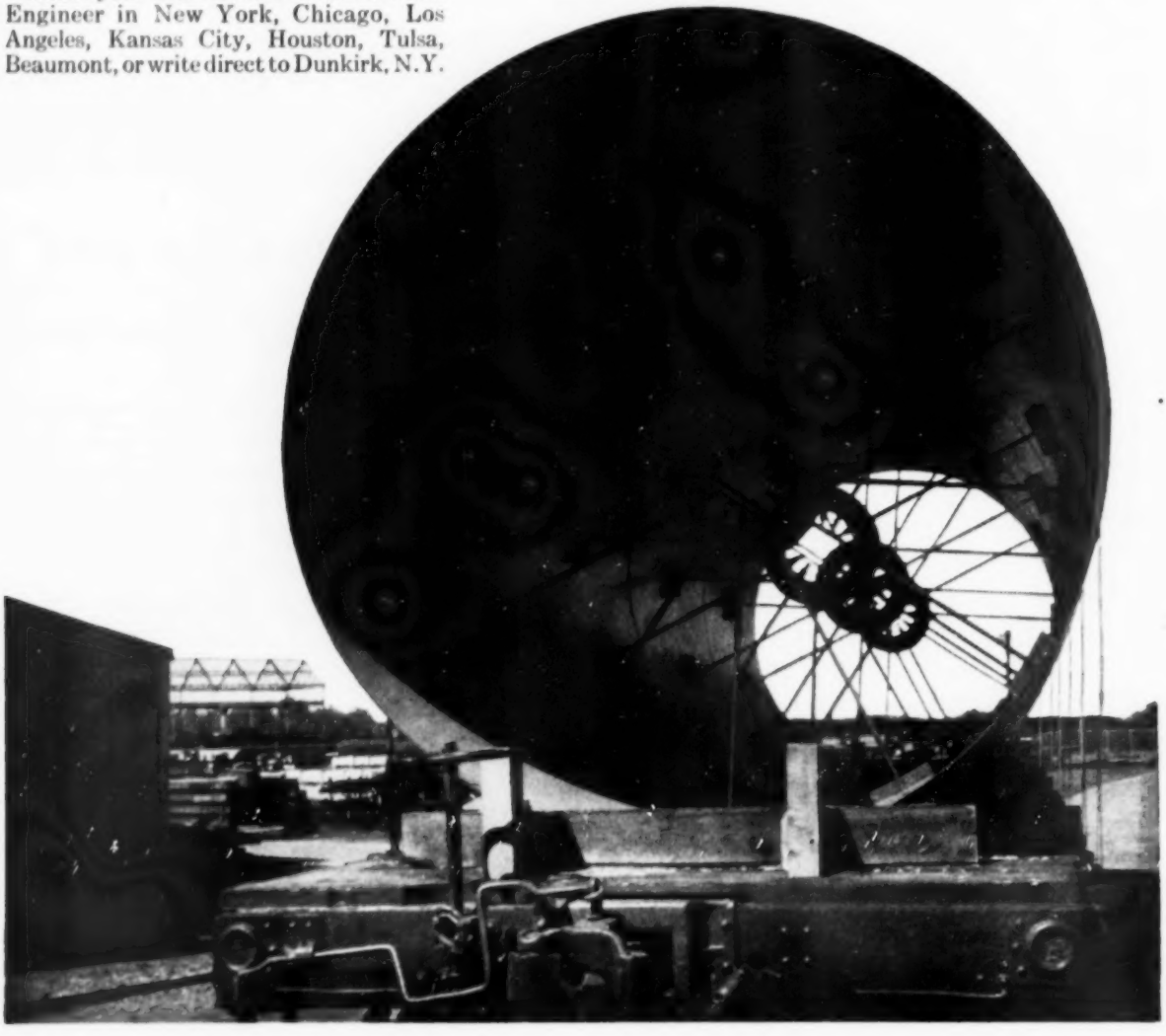
If you have a difficult metal-fabricating problem—a problem that challenges the imagination, that points to new equipment or offers new opportunities to cut production costs—we invite you to let Alco's facilities and experience produce the answer.

Contact your nearest Alco Products Sales Engineer in New York, Chicago, Los Angeles, Kansas City, Houston, Tulsa, Beaumont, or write direct to Dunkirk, N.Y.

ALCO facilities

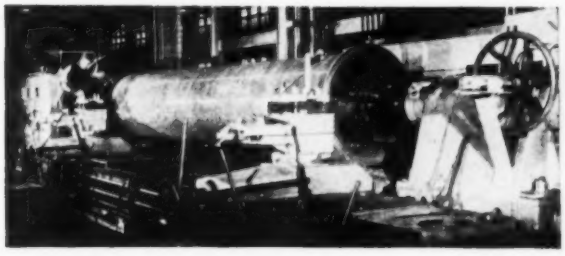
Answers to

TUNNEL INTERLININGS furnished by Alco in cold-rolled, carbon-silicon steel sections 40 ft long and 10 ft 6 in. in diameter will reinforce the outlet end of New York City's new $44,000,000 deep-rock East Delaware Water Supply Tunnel. Held to close dimensional limits, electric fusion welded throughout, they are the latest of many special piping sections fabricated over the years by Alco for New York water supply projects.

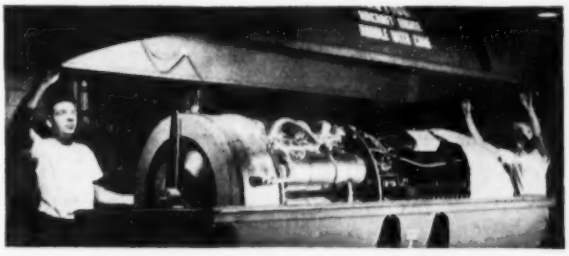


and experience produce...

New Industrial Problems



GIANT LATHE at Alco's 31-acre Dunkirk plant finishes and faces both flanges simultaneously on steel pipe up to 41 in. in diameter! Special machines like this, many of them Alco designed and all guided by the skilled hands of veteran craftsmen, help Alco solve the toughest of metal-fabricating problems.

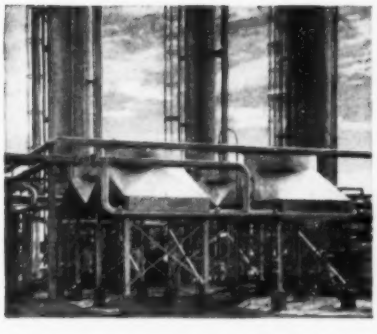


STEEL "CANS" FOR JET ENGINES, mass-produced by Alco, are carefully engineered to meet strict Air Force specifications. Example: they must "provide a barrier against the entry of water, dust, air and moisture *without* the aid of separately applied sealing compounds or materials."

ALCO

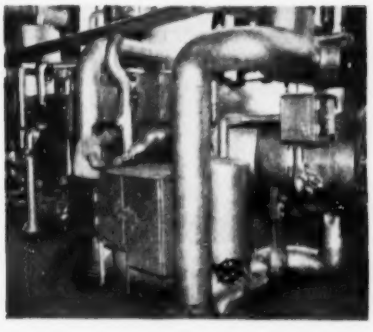
ALCO PRODUCTS DIVISION

AMERICAN LOCOMOTIVE COMPANY • DUNKIRK, NEW YORK

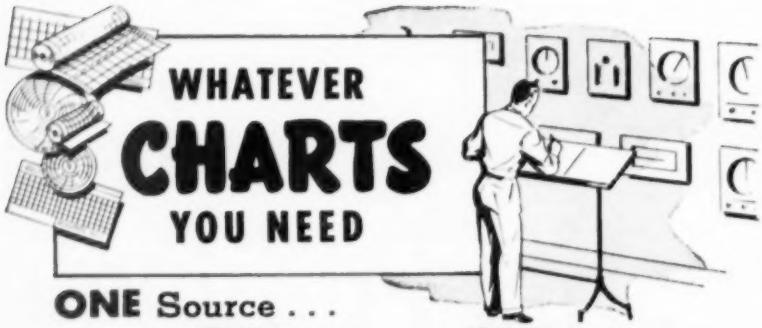


"UNI-BUNDLE UNITS," with their specially fabricated steel headers, demonstrate the versatility of Alco Aircoolers. Vertical partitions welded in the headers allow several different vapor or liquid streams to be handled in a single tube-bundle. Here, for example, at a large Southwestern natural gasoline plant, the Alco Aircooler at right not only cools the oil but also condenses the overhead vapor from the stream.

"TRAIN" HEAT EXCHANGERS, designed and built of nickel steel by Alco for the Tennessee Gas Transmission Company's new gas processing plant (the world's largest) at Gabe, Kentucky, helped cut both installation and operating costs. Their flange-to-flange construction minimized the amount of connecting piping required, while their huge size (42 in. in diameter, 150 ft long) assured maximum processing efficiency.



SPECIAL ALCO FLEX-TUBE EVAPORATORS at the Carolina Power and Light Company's new 150,000-kw plant at Goldsboro, N. C., produce vapor containing not more than 0.5 parts per million of mineral solids, hold make-up to less than one-half of one per cent. With its patented Flex-Tube construction, this Alco evaporator offers industry a positive-acting thermo-mechanical descaling device for straight-tube installation.



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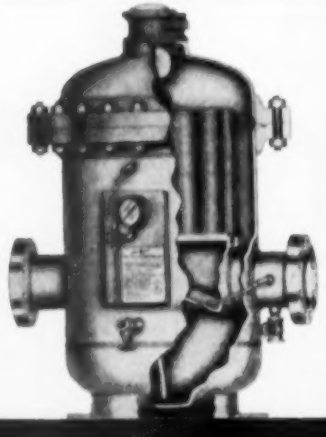

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5 MICRON
FILTERS
for finished
PETROLEUM
PRODUCTS

Designed to remove dirt (down to 5 microns) from finished petroleum products . . . removal of this microscopic rouge lengthens the life of jet and gasoline aircraft engines, pumps, meters, valves, and fittings. They are compact in size and are built for operating pressures from 0-2500 psi. EXCEL-SO Filters can be built to any code requirement, API-ASME, ASME or state codes for unfired pressure vessels. They also meet requirements of JAN or MIL specifications. Available in capacities from 10-2000 G.P.M. Special "Throwaway" Plastic Filter Bundle available on request. Write for Bulletin FO-52.

WARNER LEWIS COMPANY

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What's New!

Small Motors Service

. . . plan; a new service being provided by the company for repair and replacement of fractional and integral horsepower motors and generators 4-page *Booklet GEC-972* outlines type of service being provided and lists present "service stations" in U. S. and Canada. General Electric Co., Schenectady 5, N. Y.

Circle No. **21** *on Reply Card*

Guide to Anhydrous Ammonia

. . . use in cylinders; description of physical, chemical properties, specifications, applications, handling techniques and safety precautions; in 20-page manual. Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

Circle No. **22** *on Reply Card*

Vacuum, Pressure Control

. . . device which allows a system to be shut down without disturbing the setting; illustrated with many photos and graphs, 26-page bulletin gives complete technical details, theory behind the operation, and prices of various units. Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y.

Circle No. **23** *on Reply Card*

Vertical Turbine Pump

. . . developed first as deep-well pump, and now being marketed by manufacturer for such diversified jobs as recirculating cooling water, condensate return, booster service, fire prevention, etc.; in 12-page *Bulletin W-450-B41*. Worthington Corp., Harrison, N. J.

Circle No. **24** *on Reply Card*

Two-in-One Balance

. . . combining purposes of analytical and high precision research balance; performance features and construction outlined in 6-page bulletin. Voland & Sons, Inc., Relyea Place, New Rochelle, N. Y.

Circle No. **25** *on Reply Card*

Arc Welding Machines

. . . in over 20 different models with AC, DC and inert-gas power; 44-page *Catalog* 1340 gives a complete description, with illustrations and also includes sections on accessories and electrodes required for particular jobs. Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y.

Circle No. **26** *on Reply Card*

The practical way to save pipes, tanks, derricks, buildings, pumps, roofs, fences

STOP RUST! with RUST-OLEUM

RUST-OLEUM is the *practical, sensible* answer to your rust problems. Cuts your maintenance costs, because it may be applied *directly over rusted surfaces* after wirebrushing and scraping with sharp scrapers to remove rust scale and loose particles . . . costly sandblasting and chemical pre-cleaning are not usually required. This often enables *one man* to do the work of two with RUST-OLEUM! Practical, too . . . because RUST-OLEUM beautifies as it protects in *all colors, aluminum,* and *white.*

We'll be happy to show you convincing proof that RUST-OLEUM can cut your maintenance costs . . . and last longer when applied over rusted surfaces. Get the facts, today! Prompt delivery from Industrial Distributor stocks in principal cities in the United States and Canada.

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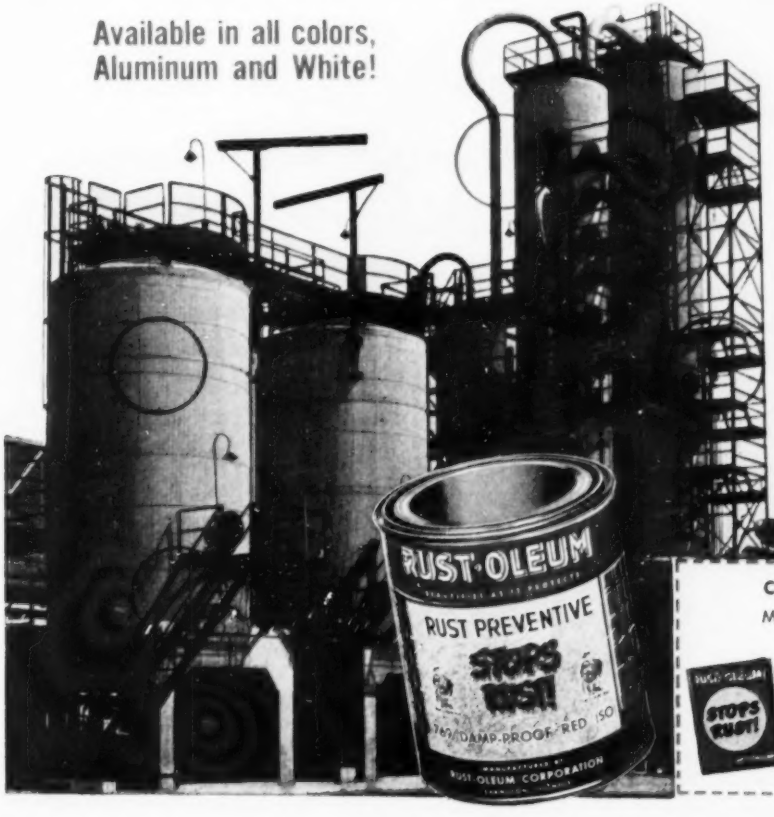
May be applied directly over rusted surfaces without removing all the rust!

Available in all colors, Aluminum and White!



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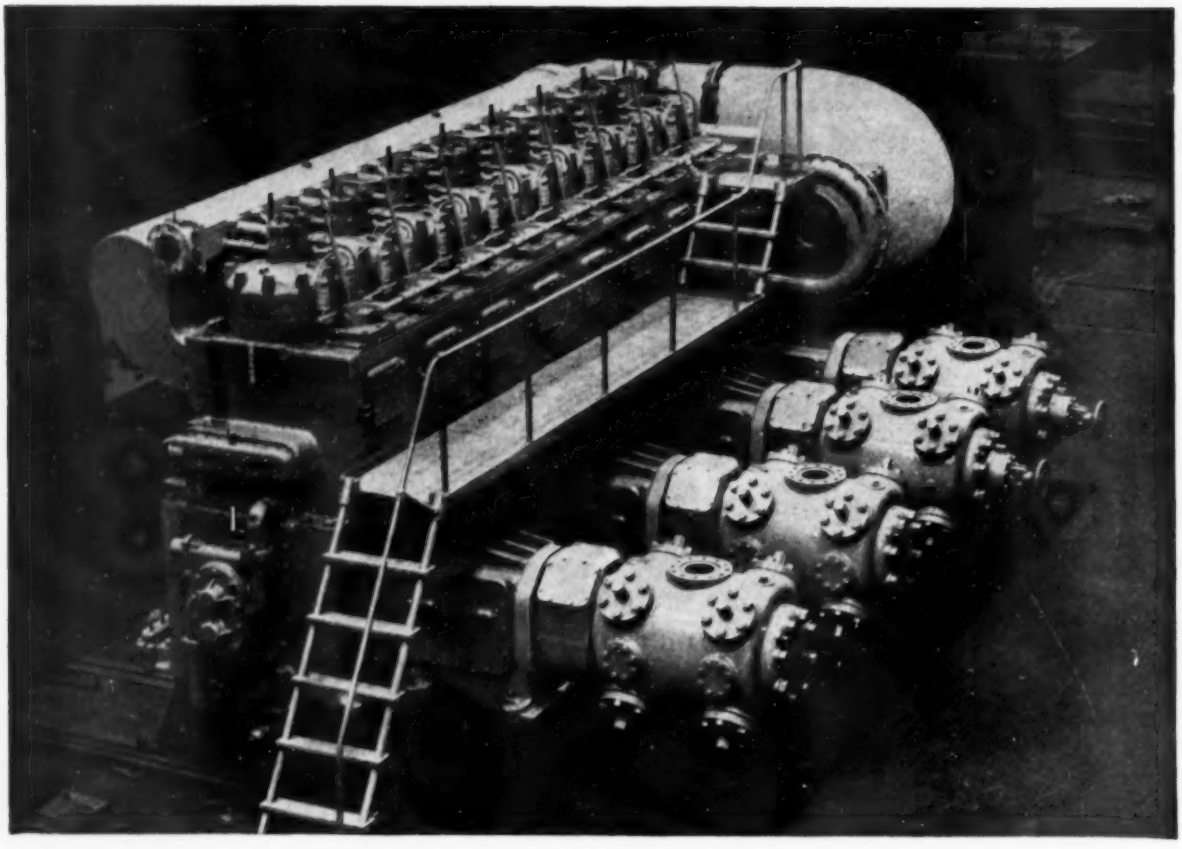
- ☐ Have A Qualified Representative Call
- ☐ Full Details On Free Survey
- ☐ Complete Literature
- ☐ Nearest RUST-OLEUM Source



Clark 2-Cycle Turbocharged "Right Angle" Heralded As Most Significant Development In Compressor History

Revolutionary changes in gas-engine-driven compressor design set new records for power (50% increase), fuel economy (10-15% decrease) and cooling water load (25% decrease)

THE recently developed Clark 2-Cycle Turbocharged Right Angle Compressor has set new, industry-wide standards for power and operating economies, reports Clark Bros. Co., Olean, N. Y.

Climaxing an intensive 7-year Clark development program, the availability today of this completely new, turbocharged compressor design provides the realistic and ready answer to increasing cost of gas, inadequate cooling water supply in certain areas and the need for more powerful, more compact units. Clark engineers list the following points in support of these claims:

50% More Power

Fifty percent (50%) more power is delivered than by any previously built non-turbocharged unit of comparable bore and stroke (without any encroachment on overload carrying ability). The stepped-up power output means reduced building, foundation, piping and maintenance costs as well as decreased operating personnel.

10-15% Less Fuel Consumed

Conservatively rated, the new Clark unit is guaranteed to burn 10 to 15% less fuel than the best non-turbocharged, high compression, gas-engine-driven compressor previously built.

25% Less Cooling Water Load

Cooling water requirements per bhp are twenty-five percent (25%) less than those of the best non-turbocharged, high compression, gas-engine compressor previously built (including scavenging air

intercooling duty). This is important not only in arid locations, but means fewer cooling towers, smaller pumps, smaller piping and smaller motors to drive water pumps.

Flat Fuel Consumption Curve

Fuel consumption remains practically constant between seventy percent (70%) of load and maximum load, assuring optimum fuel economy over the entire operating range.

Quiet Operation

Energy, formerly lost in noise, is now harnessed for useful work by the Clark Turbocharger. This, plus a fully insulated exhaust manifold and en bloc construction, make it the quietest, smoothest operating gas-engine-driven compressor ever built. There are no exhaust pulsations.

UNITIZED, MATCHED DESIGN

Both turbocharger and compressor were designed and built by Clark as matching components. The result, say Clark engineers, is a highly efficient, unitized and integrated design.

The Turbocharger

The Clark turbocharger combines many of the design principles of Clark radial inflow turbines, combustion gas turbines and centrifugal compressors.

As applied to the new Clark Compressor, turbocharging is a practical means of converting waste heat into energy. It utilizes the waste heat, velocity and mass flow of the exhaust gases to drive a radial inflow turbine. The turbine, in turn, is integrally connected to a centrifugal compressor impellor which pumps air to scavenge the power cylinders and to furnish air for combustion. No scavenging cylinders are used or required.

At start-up and on light loads, the turbocharger is direct driven through a gear train from the engine crankshaft. Under all other load conditions, the turbocharger operates independently of the engine, its speed automatically conforming to the load placed on the engine.

Because the Clark turbocharger operates at very conservative speeds and temperatures, no critical, scarce materials are required for its construction.

The Compressor

While the gas-engine-driven compressor is an entirely new unit, specially designed to match the characteristics of the new Clark turbocharger, it retains many of the basic Clark "Angle" design features. Clark engineers describe it as the most rugged compressor ever built, "with a very conservative BMEP rating for a unit of its proportions."

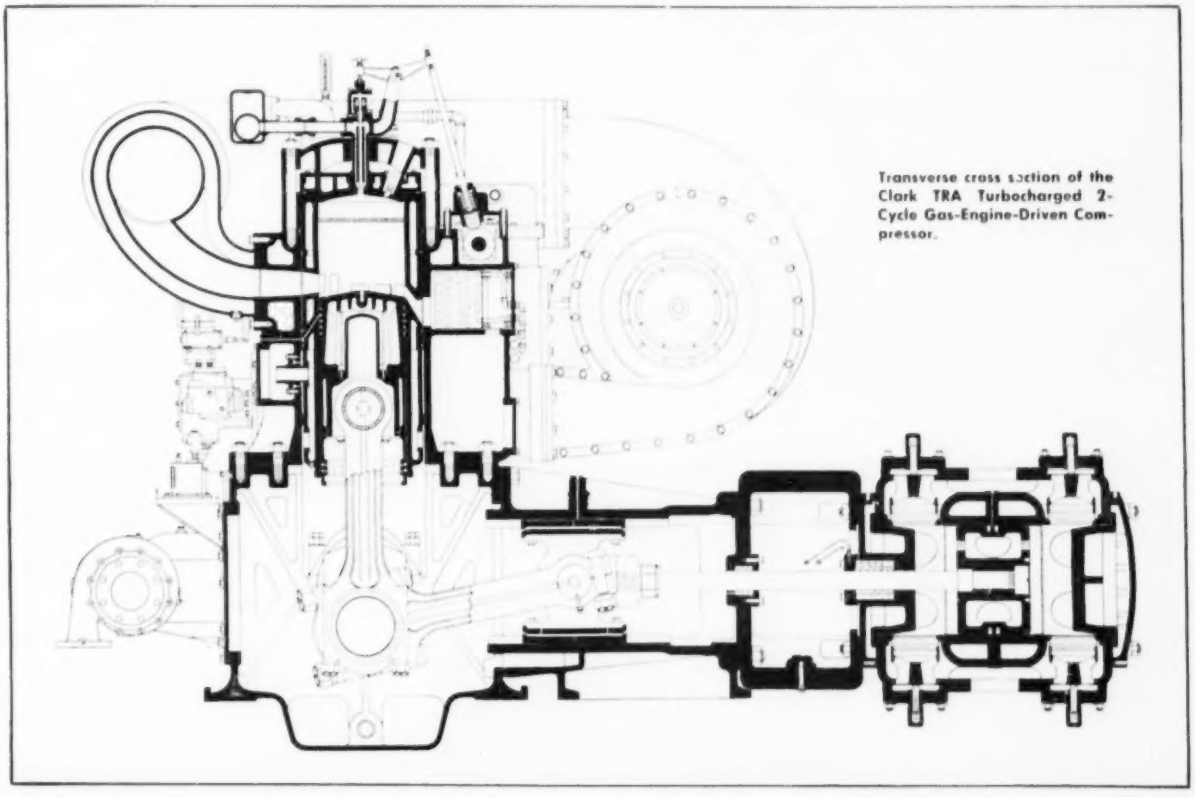
Following a long established Clark practice, the new compressor is an extremely compact, yet highly accessible 2-cycle, in-line design. It occupies considerably less space per bhp than non-turbo-charged units, because of its increased power output. Featured are: Cylinder block construction with removable power cylinder liners; full precision bearings; one-piece forged steel crankshaft; oil-cooled power piston heads and skirts; heavy, forged steel connecting rods; fully insulated, streamlined exhaust system.

MODELS

The Clark Model TRA-8, illustrated, has eight vertical in-line power cylinders of 14″ bore and 14″ stroke, developing 1320 bhp. Other size turbocharged units also are available.

Bulletin 130, with complete information on the Clark 2-Cycle Turbocharged Gas-Engine-Driven Compressor is obtainable from Clark Bros. Co., Division of Dresser Operations, Inc., Olean, N. Y.

Clark manufactures a complete line of heavy duty compressors: motor driven; gas, steam and Diesel engine driven; centrifugal and axial flow.



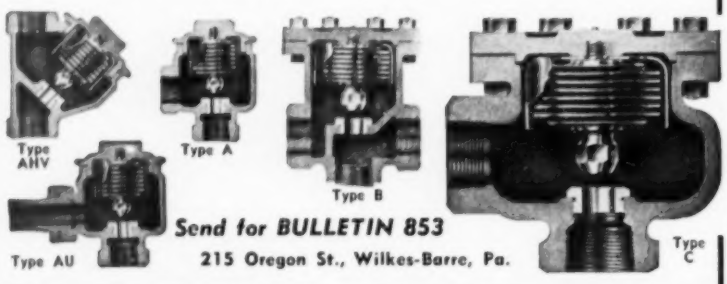
Transverse cross section of the Clark TRA Turbocharged 2-Cycle Gas-Engine-Driven Compressor.

NICHOLSON TRAPS

SAVE CAR OF COAL WEEKLY

for This Large Steam User

Following replacement of all steam traps of various makes, with Nicholson units, an Eastern college reports: — "An average coal saving of 1 carload per week besides much better heat distribution". Credit is given the higher and more even temperatures which Nicholson traps effect. See why large industrial and institutional steam users are increasingly standardizing on Nicholsons. 5 types; for heat, power, process; sizes ¼" to 2"; press. to 250 lbs.



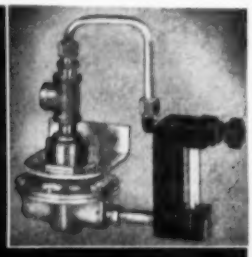
Send for BULLETIN 853

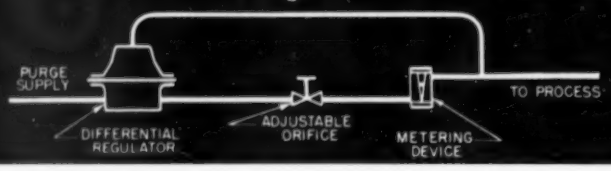
215 Oregon St., Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

CONSTANT Metered Purge Rate with PACKAGED Cono Purge





No supervision needed at installation; only two pipe connections required. By providing absolute control of differential pressure across an adjustable orifice, Cono Purge assures constant rate of flow regardless of variations in upstream or downstream pressures. Primarily for use as a purging system on flow metering service or on bubble type level gauges in chemical plants, paper mills, breweries and other industries where suspended matter or corrosive fluids must be kept out of meters and meter piping. BULLETIN H-11 shows how it works. Write for your copy today.

CONOFLOW CORPORATION
2100 ARCH ST.
PHILADELPHIA 3, PA.

Cono-Controls

CC-117

What's New!

Caustic Soda Data

. . . methods of manufacture, forms and grades, shipping and handling, in short, a comprehensive examination of the product's history, development and uses; contained in 64-page illustrated manual which can be obtained by writing on company letterhead to Columbia-Southern Chemical Corp., 420 Ft. Duquesne Blvd., Pittsburgh 22, Pa.

Cutting Production Costs

. . . with electronic controls; a revised book giving 46 new case studies which show how problems of weighing, counting, measuring, timing and cycling have been solved more quickly by electronic devices. Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.

Circle No. **28** *on Reply Card*

Remote Miniature Indicators

. . . having the combined advantages of a small size and long drum scale; 12-page *Catalog* 55-10 shows details of the pneumatically operated instrument, as well as specifications, space requirements for panel mounting. Fischer & Porter Co., 11A Jacksonville Rd., Hatboro, Pa.

Circle No. **29** *on Reply Card*

Piping and Pressure

. . . vessels; Vol. 1, No. 1 of manufacturer's new house organ, which itemizes company products and includes tables of maximum allowable stresses, ASME Boiler & Pressure Vessel Code. Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Ill.

Circle No. **30** *on Reply Card*

Flexible Metal Hose

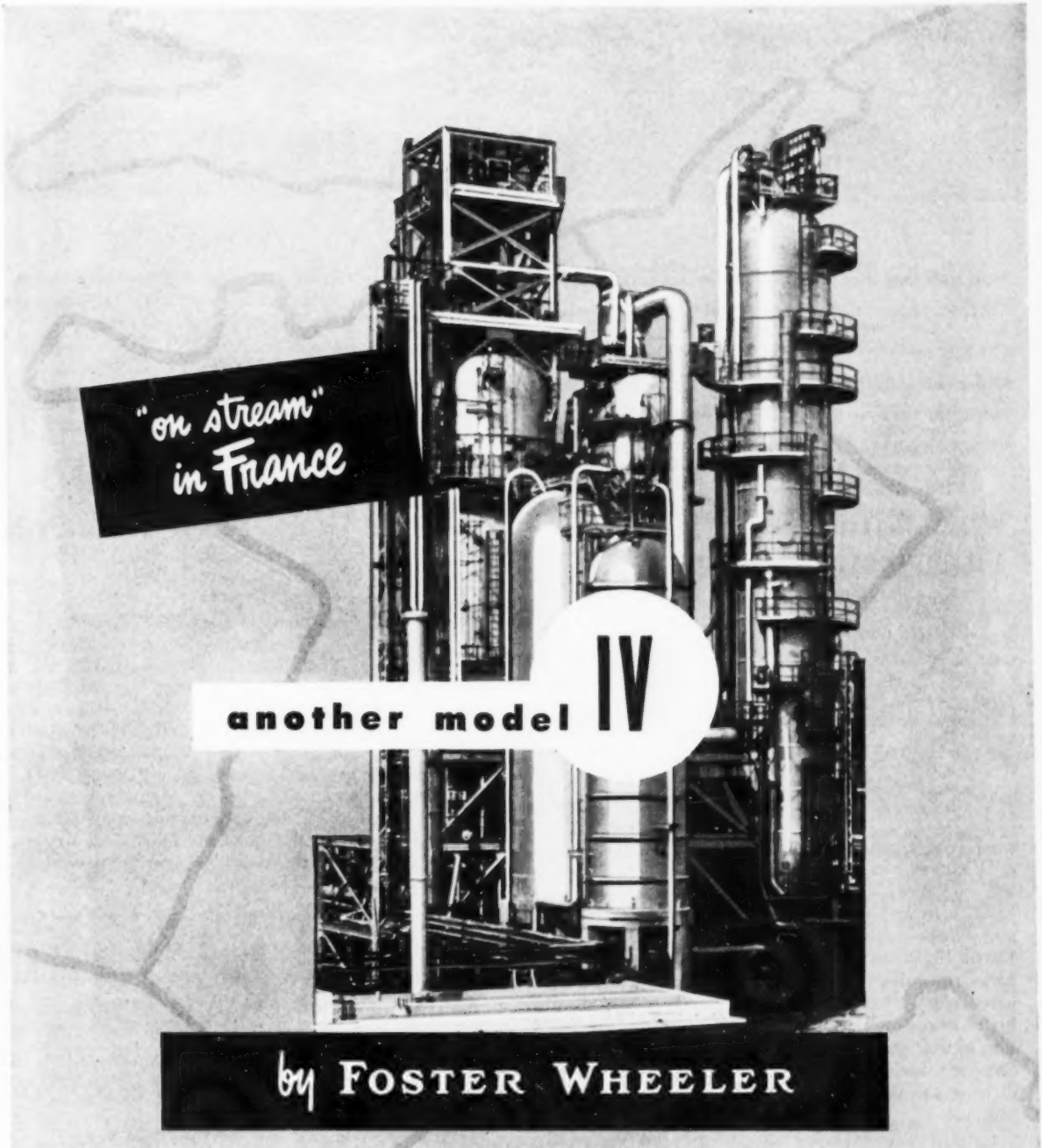
. . . in 4-page *Bulletin* 15-*D;* illustrates company's line of high pressure interlocking bronze and steel hose, tar and asphalt hose, necessary couplings, etc., with current applications and test and engineering data. Atlantic Metal Hose Co., 123 W. 64th St., New York 23, N. Y.

Circle No. **31** *on Reply Card*

Radiant-Convection Furnace

. . . of the manufacturer's "Iso-Flow," type 107-B; construction details analyzed and pictured in 4-page *Bulletin* 53-1. Petro-Chem Development Co., 122 E. 42nd St., New York 17, N. Y.

Circle No. **32** *on Reply Card*



At the Port Jerome refinery of Esso Standard Society Anonyme Francaise' on the River Seine between Paris and Le Havre, one of the first Model IV Fluid Catalytic Cracking Units in Europe was placed "on stream" this month.

It is the second Model IV unit to be completed by Foster Wheeler. A third unit is currently going on stream in Massachusetts and four more are in various stages of design and construction.

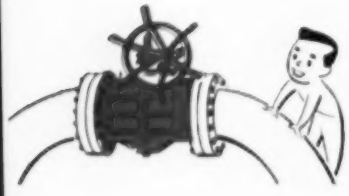
Let's Face the Facts . . .

DOES VALVE LUBRICATION

Now and then someone revives an old argument—"it costs too much to maintain lubricated valves."

On the surface, that sounds logical. But if that really was a fact, millions of Nordstrom lubricated valves in service today could never have been sold.*

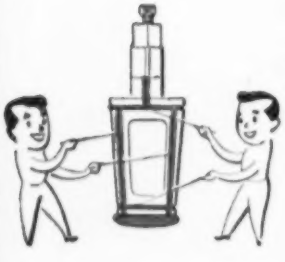
WHAT IS THE ADVANTAGE OF A LUBRICATED VALVE?



The most important function of lubricant in a Nordstrom valve is to give a tighter seal than can be accomplished through any other method yet developed. The thin film of plastic lubricant that is forced around the ports of the plug is a pressure seal in itself.

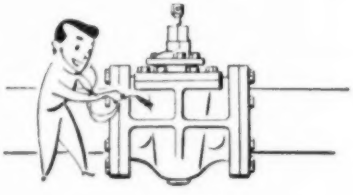
Of course, the lubricant has other obvious advantages—the same advantages it has in your automobile, or in any other mechanical equipment where metal rubs metal. The lubricant all but eliminates the possibility of galling or seizing, and consequently keeps the valve ready to operate in a hurry. A lubricated Nordstrom valve operates easily even against high line pressures, because the plug turns *within* the line, rather than being forced or wedged *against* it. Since it takes only a quarter turn of the plug to open or close the valve, it operates in seconds instead of minutes.

WHAT DOES THE LUBRICANT DO?



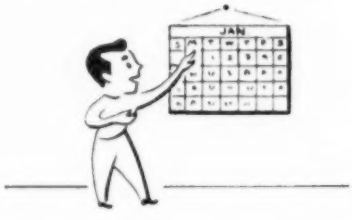
In a Nordstrom valve, lubricant is forced through a series of grooves surrounding the plug ports. There it acts as an extra seal against the little leaks that become big problems. It is also forced into a lubricant chamber at the small end of the plug where it serves as a hydraulic jack to keep the plug easy to turn. Finally, it *lubricates* . . that is, it prevents grinding wear, fills tiny imperfections that may develop, and it lets the plug slide without grating.

WILL A NORDSTROM VALVE WORK WITHOUT LUBRICANT?



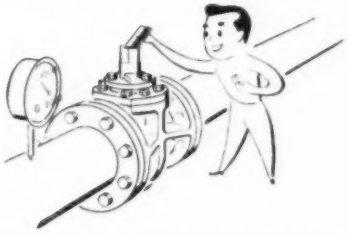
Yes, but then the whole advantage of a lubricated valve is lost. Your car will also operate without lubricant, but with proper lubricant, it is far more efficient, lasts many, many times longer, needs much less maintenance, and is safer. So is a valve. Nordstrom is fundamentally a valve—a plug valve made to exceptional standards of tolerance and quality—but it is the internal Nordstrom lubrication system which raises its performance standards above ordinary valves.

HOW OFTEN SHOULD NORDSTROM VALVES BE LUBRICATED?



Like your car, that depends upon the service—the temperature, process, frequency of operation, etc. It's hard to generalize, but your Nordstrom sales engineer can advise you. Using Rockwell lubricants, made especially for Nordstrom valves, is one way to reduce frequency of lubrication in many cases. Also, Rockwell markets mechanical lubrication equipment to make scheduled lubrication easy. Nordstrom Hypreseal valves are now built with an external fitting so that it is unnecessary to remove any parts from the valve before lubrication.

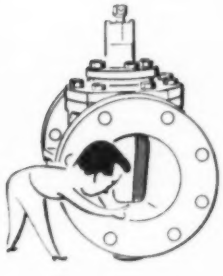
COST MONEY OR SAVE MONEY?



WHAT LUBRICANTS SHOULD BE USED?

Part of the effect of lubricating your car is lost if you use improper lubricants. That is also true of lubricated valves. Genuine Rockwell lubricants will save you money—they are the result of the longest and most extensive research into valve lubricants by any company. They are the result of years of field experience with nearly every process condition. For many services there are variations of Rockwell lubricants compounded to offset specific line conditions. Also, for many services Rockwell Hypermatic lubricant may be recommended. This lubricant, which is compressible and energizable, regenerates itself in the lubrication system, greatly reducing lubrication frequency. In any case, consult your Nordstrom sales engineer.

HOW LONG WILL PROPERLY LUBRICATED NORDSTROM VALVES LAST?



That's impossible to answer, since many of the first Nordstrom valves put into regular service are still going strong. The service has a lot to do with it, naturally. In gas service, there are many valves with more than 30 years service. In the valve-killing application of drilling rig mudlines, Nordstrom valves have been disassembled for inspection after more than 150,000 feet of hole on many occasions, found to be without wear, and returned for more service—often four times the life of ordinary valves. In a two-year paint plant test, Nordstrom valves were the only ones that did not need to be replaced because of leakage. Nordstrom files are full of such authentic field case histories—ask your Nordstrom sales engineer.

WHAT ABOUT MAINTENANCE COSTS FOR NON-LUBRICATED VALVES?

In any but the most simple services, any kind of valves need *some* maintenance. But in the case of Nordstrom valves, maintenance is generally confined to adding lubricant at intervals. Over a 20-year period, Nordstrom sales of repair parts have been less than half of one per cent of sales. In several plants in which records were kept and where Nordstrom and other valves were used, repair parts for Nordstrom valves ran about one-tenth of other makes.

The analogy to your car carries over here—if you don't lubricate it, you save on lubricant, but pay the far, far higher costs of part replacement. And more particularly, you'll need a new car much more often.

When you consider valve maintenance, be sure to count *all* the costs—not just simple service, but major repairs and complete replacement costs, shutdowns, extra labor to operate, and *all* factors.

If you do, if yours is a typical application, you'll find that year-in and year-out, the most economical valves you can use are Nordstroms.

If you'd like to discuss the suitability of Nordstrom valves for any service, let us know. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

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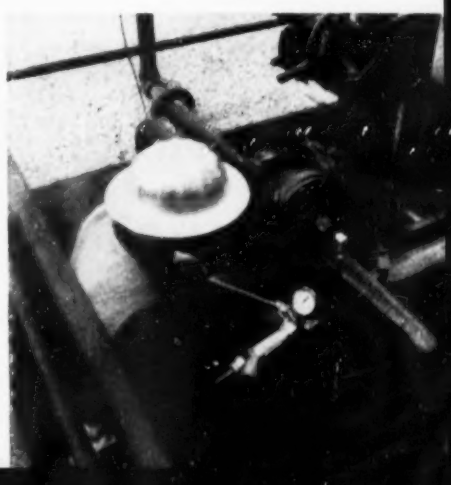
Nordstrom Valves

Lubricant-Sealed for Positive Shut-Off

* Nordstrom invented lubricated valves more than 30 years ago. Since that time several million have been installed in hundreds of widely varied petroleum, gas, chemical and other process services. With by far the most complete range of sizes and pressures, and many patents on construction details, Nordstrom is the leader in lubricated valves.



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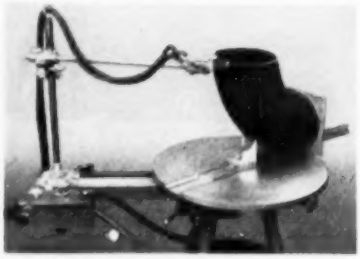

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Write for Bulletin FC-2

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What's New!

Sulfur from Hydrogen Sulfide

. . . by B. W. Gamson and R. H. Elkins; an article reprinted from *Chemical Engineering Process* containing a review of the current literature, calculation procedure, restrictions on unit design, etc. American Institute of Chemical Engineers, 120 E. 41st St., New York 17, N. Y.

Circle No. **33** *on Reply Card*

Gas Specific Gravity

. . . measurement instruments, pneumatic type; 4-page *Catalog* 14-*A*-12 shows components of system, details several applications and lists general specifications for specific gravity ranges. Fischer & Porter Co., 842 Jacksonville Rd., Hatboro, Pa.

Circle No. **34** *on Reply Card*

Liquid Filters

. . . for flows between 1.8-900 gpm and operating pressures from 125-1000 psi on standard models; specifications and a selection chart to help choose the right filter for the job are included in 12-page *Bulletin MK*-0553. Cuno Engineering Corp., Meriden, Conn.

Circle No. **35** *on Reply Card*

Visualized Process Data

. . . with the manufacturer's "Panelgraph" control panels; 4-page *Bulletin PI*-153 outlines briefly the uses these panels have in many phases of industry, together with separate illustrations of components used in making up the units. Panellit, Inc., 6312 N. Broadway, Chicago 40, Ill.

Circle No. **36** *on Reply Card*

Self-Locking Nut

. . . a combined standard nut and retainer, which is said to be removable without damage to the bolt; construction features and typical applications discussed and illustrated in 8-page bulletin. Security Locknut Corp., North Ave. and 15th Ave., Melrose Park, Ill.

Circle No. **37** *on Reply Card*

Drafting Machines

. . . including gravity compensated, track type, civil engineering and detail devices; description and illustration of mechanical properties, as well as pictures of the latest types of scales for all drawing uses; in 20-page manual. Charles Bruning Co., 4700 Montrose Ave., Chicago 41, Ill.

Circle No. **38** *on Reply Card*

WHEN YOU NEED *Desalting*

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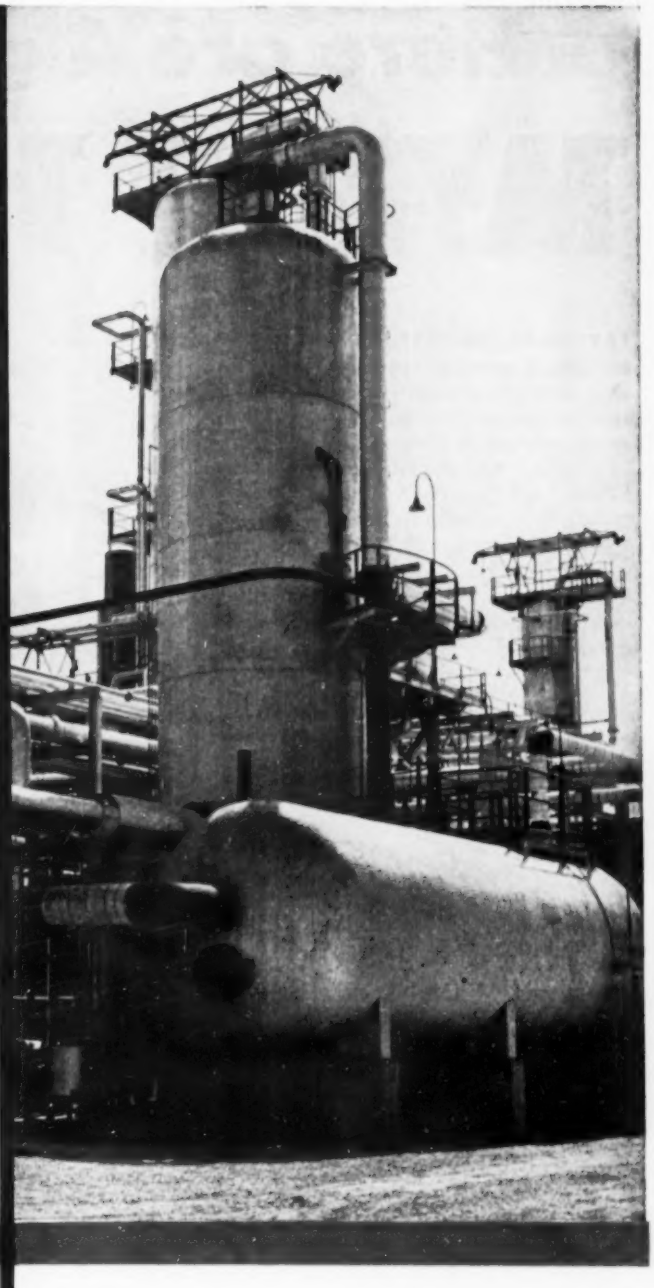
At Tretolite, we believe that we can *sell* you the best desalting chemicals available; we will *give* you the best service.



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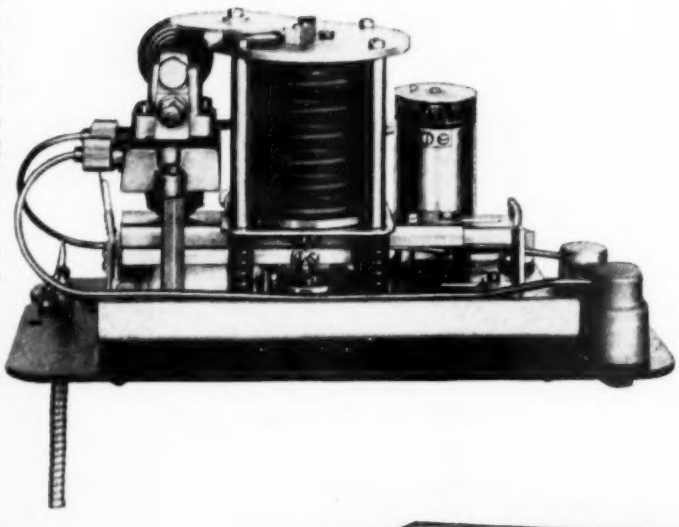
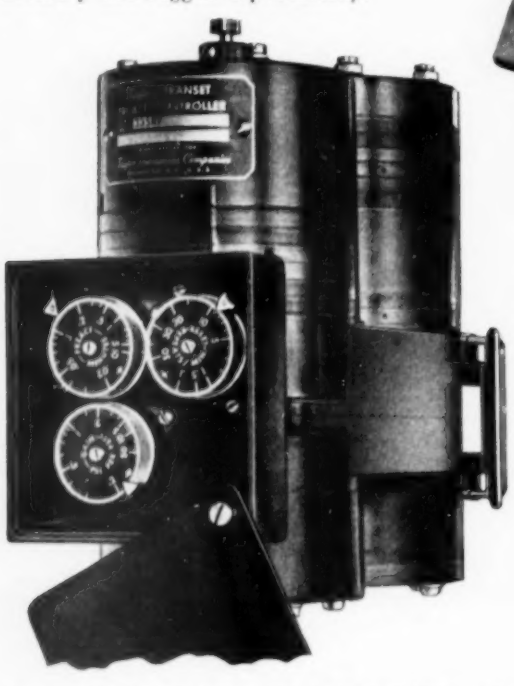
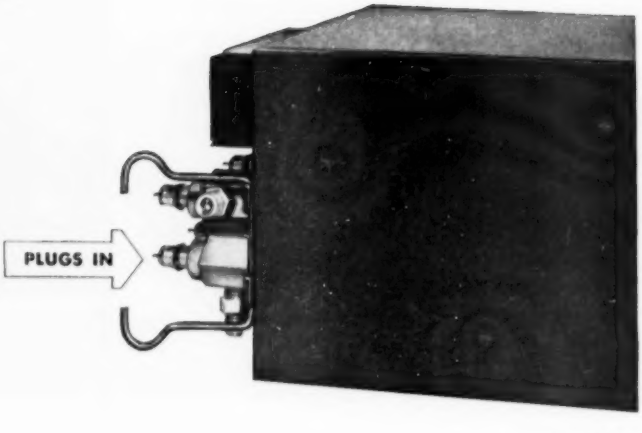






*Trade-Mark

THE BRAND NEW TRI-ACT* CONTROLLER combines all 3 response adjustments (gain, reset rate and PRE-ACT* response.) It is the most complete controller, giving the very best control on the more complex processes, particularly those with long time constants, and load changes, requiring both derivative and reset adjustments. Gives faster recovery on load changes; start-up without overpeaking; the benefits of automatic reset without its evils.

The One Knob and Two Knob BI-ACT* Controllers are interchangeable with the TRI-ACT controller in a matter of seconds. They are ideal for those applications where control requirements are less demanding.

RUGGED SELF PURGING SLEEVE OR CASE keeps out corrosive fumes, dust and dirt and gives mechanical protection to receiver mechanism. One common, self sealing manifold gives plug-in connections to both receiver and controller. You save panel space, because units can be mounted only a few inches apart. You save money, both in labor and materials on installation, thanks to the simplified piping and mounting.

why you should look at the CONTROL SYSTEM

Are you getting the biggest value out of your investment in instrumentation? There are many facts—and users—to back up the claim that the Taylor TRANSET system is the finest, most economical control system made today. Here are 4 good reasons why you should look into the TRANSET system:

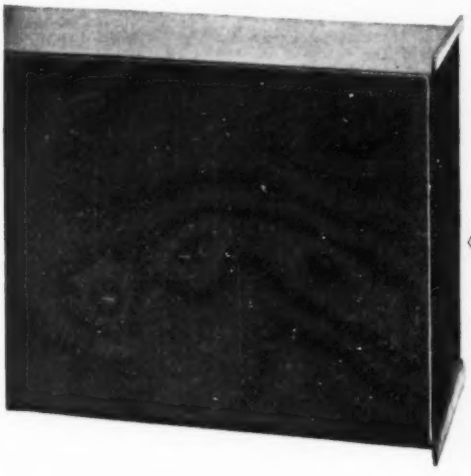
1. Ruggedness. Large, powerful bellows in all receivers to assure positive actuation. The TRANSET system is not laboratory instrumentation. It is built for rugged industrial use. In fact, mountings attach to panel so sturdily that they support the weight of an average man.

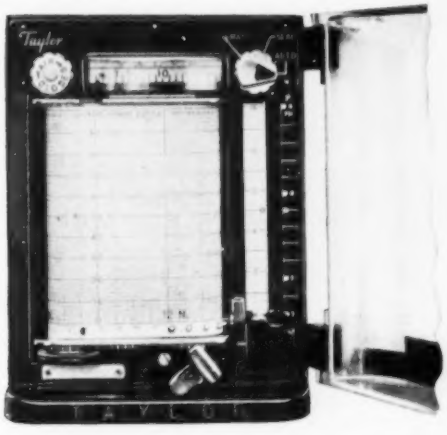
2. Dependability. TRANSET controllers have rugged diaphragms that will take pulsating signals without failure. The force-balance principle provides for minimum air use, hence less chance of clogging. O-ring seals on plug-in connections eliminate internal port leaks. The receiver case is self-purging.

3. Accuracy. Both indicating and recording receivers are calibrated to an accuracy of $\pm\frac{1}{2}\%$.

4. Flexibility. Due to plug-in feature both BI-ACT and TRI-ACT controllers and indicating and recording receivers are instantly interchangeable, making "second guessing" entirely practical.

Your Taylor Field Engineer will be glad to demonstrate these features. It will cost you nothing to call him in, and may save you both money and headaches. Write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.





THE TRANSET SINGLE PEN RECORDER has automatic-manual unit: remote set-point indicator; 30 day linear chart, 3 hours visible. Chart reads from left to right on rectilinear coordinates, as an engineer would normally plot variables for study. Continuous valve position indicator on separate scale tells valve air pressure at a glance. Chart read-back device gives easy access to past records. Other receivers include: Single Duty Bi-Record Receiver, Pneumatic Set Receiver, the TRANSET Indicator. On all instruments adjustments can be reached conveniently from the front.

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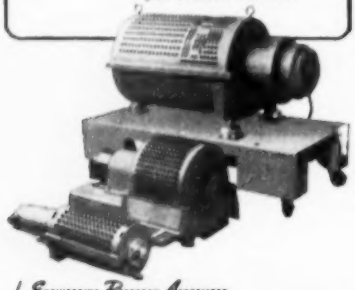

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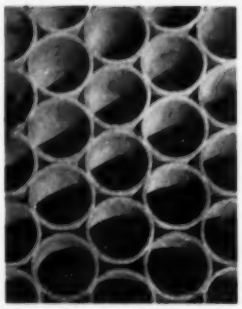

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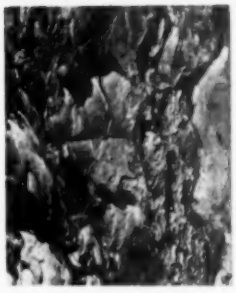

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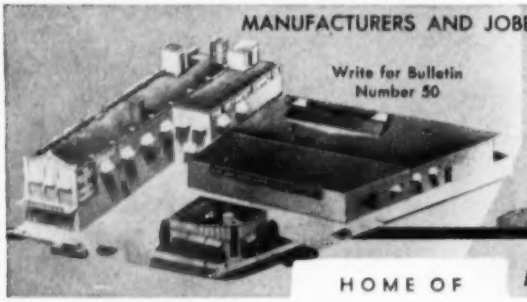

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Ethylene Amines

. . . physical, chemical and physiological properties, specifications and shipping data; described in 4-page *Technical Bulletin F*-8163. Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.

Circle No. **39** *on Reply Card*

Process Metering

. . . and controls; 16-page *Bulletin* 17 offers ranges, basic specifications and detailed literature references on the firm's complete line of automatic controls for 17 different process variables. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle No. **40** *on Reply Card*

Stud Welded Fasteners

. . . for securing refinery equipment insulation; several types discussed 13-page *Data Sheet* 400.5, with schematic drawings showing methods of use. Nelson Stud Welding, Gregory Industries, Inc., Lorain, Ohio.

Circle No. **41** *on Reply Card*

Spectrophotometry

. . . and what today's executives should know about it; a 14-page Bulletin 295-23 explaining in layman's language what spectrophotometry is, what its uses are, and how it works; profusely illustrated. Beckman Instruments, Inc., South Pasadena 1, Calif.

Circle No. **42** *on Reply Card*

Pneumatic Conveying Unit

. . . of the negative pressure type, for handling bulk materials; operating principles and applications outlined in 6-page Bulletin 18-D. Sprout-Waldron Mfg. Engrgs., Muncy, Pa.

Circle No. **43** *on Reply Card*

Did You Miss These?

The following, reviewed originally in July, have aroused considerable interest among the readers. They are repeated briefly as a service to those who might have missed them the first time. For details or literature, please use the regular Reply Card in this issue.

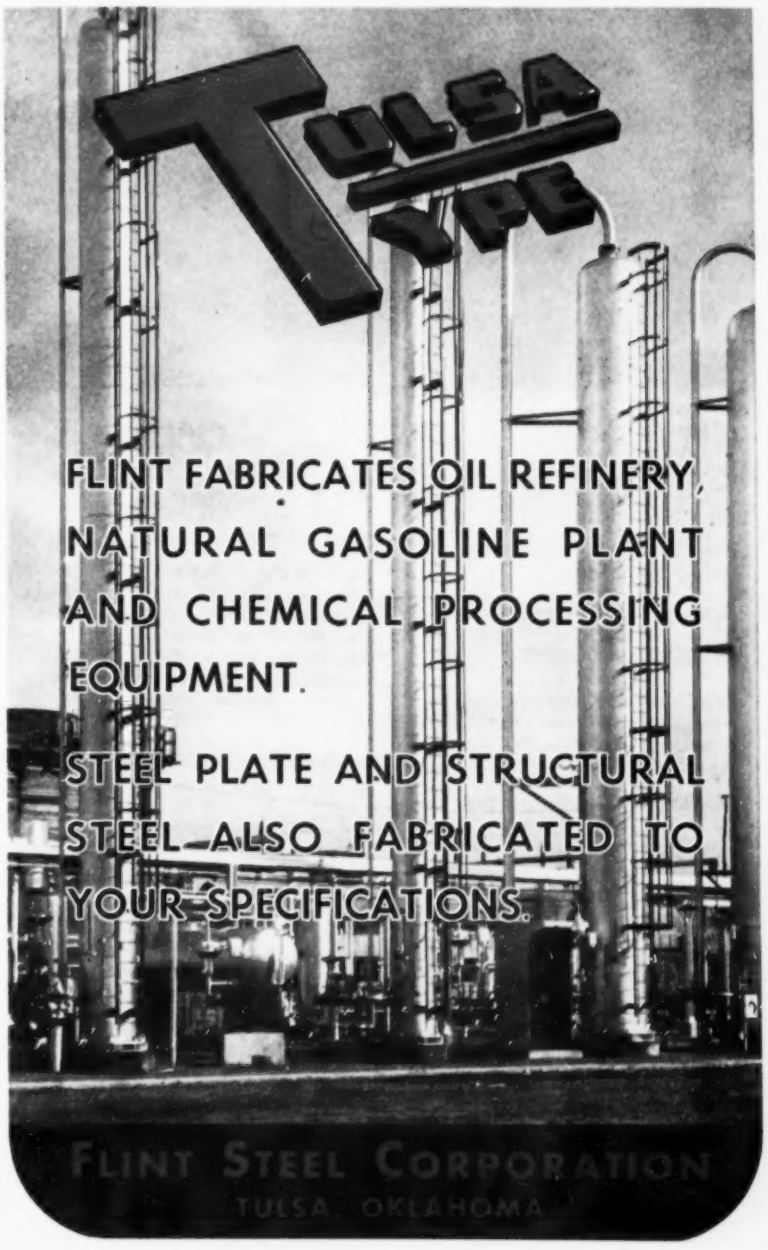
Reagent Detects Water Traces In Many Petroleum Products

. . . without heating. "Mois-Tec" is added drop by drop to a given quantity of sample until a blue-green end point is reached. Each drop of the compound is equivalent to 0.2 mg. of water. It is said to be suitable for use with gasolines, oils, greases, solvents, polyglycols, and derivatives. Manufacturer states it will not work with glycerine, acetone, ethylene, or propylene glycols, methyl, ethyl or isopropyl alcohols. R. P. Cargille Laboratories, Inc., 117 Liberty St., New York 6, N. Y.

Circle No. **44** *on Reply Card*

New Computer Will Handle Linear Function Directly

. . . eliminating time ordinarily spent in processing of data. The "Graph-Analogue" is said to be most useful in reading infrared data, since required curve ratios can be obtained in one operation. Graphs or curves are multiplied directly, distances divided into equal spaces, or into logarithmically proportional lengths, or into arbitrary non-linear proportions. The computer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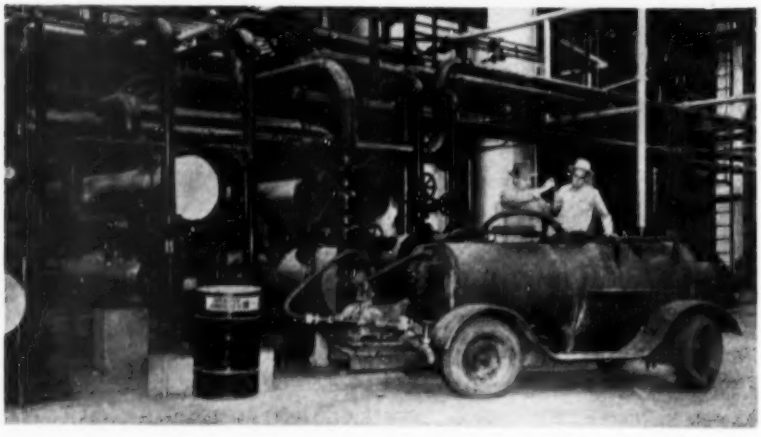
He should have an inquisitive mind and like to probe into the "why" of things, and be able to explain to others what he has found out.

Experience in magazine or newspaper production is desirable but not essential.

Duties will include editing and rewriting copy, with responsibility for specific departments in the magazine, and field trips to gather data for original articles. Location is in Cleveland, and salary is open. Send details to:

EDITOR, PETROLEUM PROCESSING

1213 West Third Street • Cleveland 13, Ohio



How refiner saved $1800 cleaning heat exchangers and condensers

Oakite Compound No. 32 soaks scale off tubes— no pulling of bundles

This Oklahoma refinery used a lot of manpower during turnarounds—pulling exchanger bundles for cleaning, and replacing with spares. Then they called in Oakite.

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is said to be helpful in data reduction where oscillogram recordings can be read directly in final dimensions, regardless of the calibration curve shape. GraphAnalogue is essentially a slide rule, 14 in. long, 5 in. wide, and ½ in. thick. It is mechanical, with a built-in dove tail slot for use on boards or in gangs. Main body is aluminum. The slide, designed to be self-locking in any position, can be adjusted to the desired friction by two set screws. Gerber Scientific Instrument Co., 89 Spruce St., Hartford 1, Conn.

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Catalyic Processes

. . . in petroleum refining, described in the *Houdry Pioneer*, June, 1953; with illustrations of various types of catalysts, physical properties and performance charts. Houdry Process Corp., 1528 Walnut St., Philadelphia, Pa.

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Transistor Applications

. . . in modern industry; a discussion of how transistors were developed, how they are built and used, and what can be expected from them in the future; 24-page booklet. Radio Corp. of America, RCA Bldg., 30 Rockefeller Plaza, New York 20, N. Y.

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Bubble Tray Design

. . . and construction; 12 pages of diagrams and text dealing with, among other things, the advantages of the manufacturer's Truss-Type construction. Fritz W. Glitsch & Sons, Inc., P.O. Box 6227, Dallas 2, Texas.

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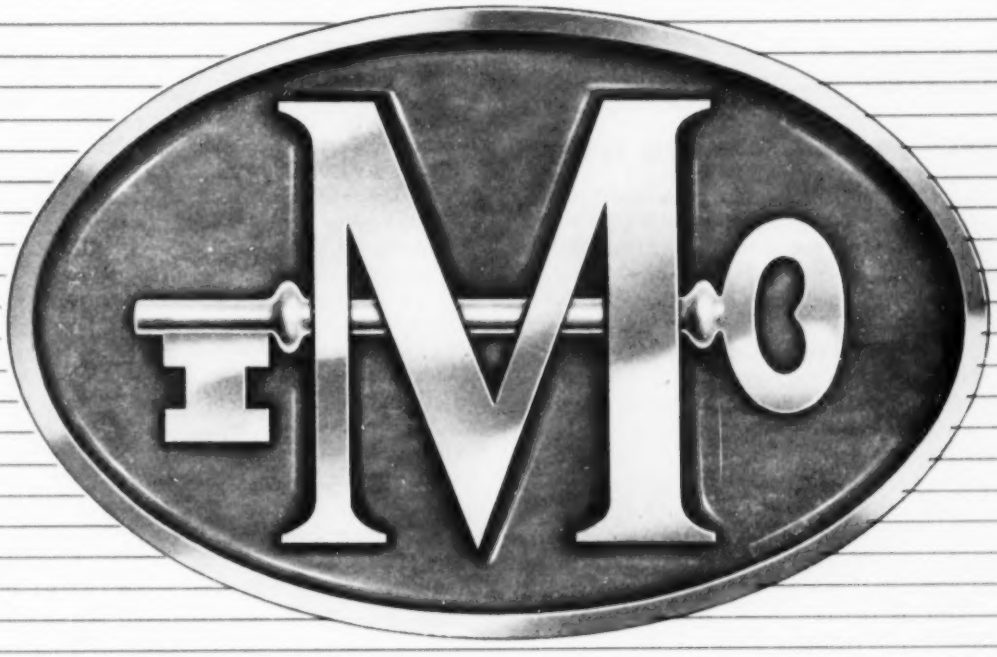

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EDITORIALS . . .

With Stocks Today, How BIG is Big?

DEALING in production and inventory items in the hundreds of millions of barrels, petroleum refiners are not easily disturbed by figures running into nine digits. Their total stocks of products today, however, are at a level where they are being given more than the usual amount of study.

Refiners' total inventories of finished and unfinished products May 31 were reported by the Bureau of Mines as 394,666,000 bbls., almost one fourth larger than the same date in 1952, the increases being in gasoline and the middle distillates. However, the summer of '52 was an abnormal period because of the strike of refinery workers in May. Compared with May 31, 1951, primary product stocks are around 14% larger.

The first concern is whether refiners' stocks are too high in terms of immediate demand. More important to the industry, though, is the long range view: whether the trend in stocks is towards a level entirely out of balance with our estimated future requirements and other factors that must be considered.

Those who support the view that inventories are now becoming too heavy point out that last summer, with gasoline stocks greatly depleted during the strike period, refiners still fully met the seasonal demands without any inconvenience to the public. At the same time, through increasing their runs to stills, they built up middle distillate stocks to the point they were able to meet the demands of the heating season without difficulty. This summer, while demand is higher, inventories are at a new peak and crude runs to stills are around 3% larger than last year at this time. It is also brought out that we have a larger surplus refining capacity than ever before, over 1,000,000 bbls. daily, which can be called into use to meet any demand for any product that may arise.

Some points can be brought out to buttress the case for refiners' product stocks not being too large today in terms of long-range demand. Gasoline stocks now are some 44% larger than at the same time in 1948, but the gain is in line with the increase in demand of 45% in the same period. Distillate stocks are 80% larger, and demand 61% greater than in 1948. Residual fuel oil stocks are less than in 1948, while demand has increased 7%.

Refiners' transportation facilities — product pipelines, barges, tankers, tank cars, storage tanks at plants and terminals—have expanded with growing markets to the point that today a large portion of primary inventories are required at all times to keep the transportation system filled. A survey last year by the National Petroleum Council showed that only 60% of clean products in storage (gasoline, kerosene and distillates) could be actually merchandised; 40% was "unavailable" in the sense of having to remain in the transportation system. With heavy fuel oils, 58% could be distributed to markets, 42% was "unavailable."

It is now estimated that demand for oil products in the two winter quarters of the year averages about 900,000 bbls. daily larger than in the two summer quarters. Only a few years ago the distance between the peak and the valley was 500,000 bbls. daily average. Relatively larger stocks are required now to meet peak seasonal demands, unless runs to stills are materially stepped up in the winter.

In view of the uncertain conditions today both at home and over the world, there is sound reason for refiners holding some portion of their inventories against an emergency or defense demand, even though they are not specifically called on to do so. Since 1950 we have had a number of unanticipated emergency demands. First there was the Korean situation. In 1951 and 1952 it was a call to supply many million barrels of products to foreign markets shut off from their usual source of supply by the closing of the Anglo-Iranian refinery in Abadan. Last year there was also the strike.

In sizing up the inventory situation today, the industry should include the above and other conditions and not assign an exaggerated importance to the psychological factor of stocks at the highest level in the industry's history.

—V.B.G.

Imbalance in Academic Research

The recent announcement by the Atomic Energy Commission of its award of 47 additional contracts totaling $2,183,144, largely to universities, for research focuses attention anew on the distortion in academic research work resulting from the huge sums government agencies are spending in these institutions. The progress of basic scientific work on behalf of industry is severely affected.

For the 1952-53 academic year, federal government agencies allocated $340,000,000 for scientific research at non-profit institutions, and this is only a part of their total research expenditures. Grants by industry, foundations and others to colleges amounted to not over $75,000,000 in the same period. The schools' programs are out of balance both through the government financing of such a large proportion of the work there and through its assignments being mainly practical research in the physical sciences, to the neglect of the social sciences.

Against this somber background it is heartening to note the incorporation of the Council for Financial Aid to Education, Inc. Among the five incorporators, all prominent business men in this country, is Frank W. Abrams, board chairman, Standard Oil Co. (New Jersey). Purpose of the Council is to promote a better understanding of the need for securing adequate financial support of higher education in this country and to serve in an advisory capacity to business corporations in making contributions to support the schools. The petroleum industry, which annually draws on the scientific schools and liberal arts colleges to recruit new personnel, should be among the chief supporters of the Council.

The Council for Financial Aid to Education will not itself distribute funds or solicit contributions. Rather it will serve in an advisory and cooperative role both to prospective contributors and educational institutions. In addition to Abrams, incorporators include Irving Olds, until recently board chairman U. S. Steel; Alfred P. Sloan, Jr., Chairman General Motors.

—V.B.G.

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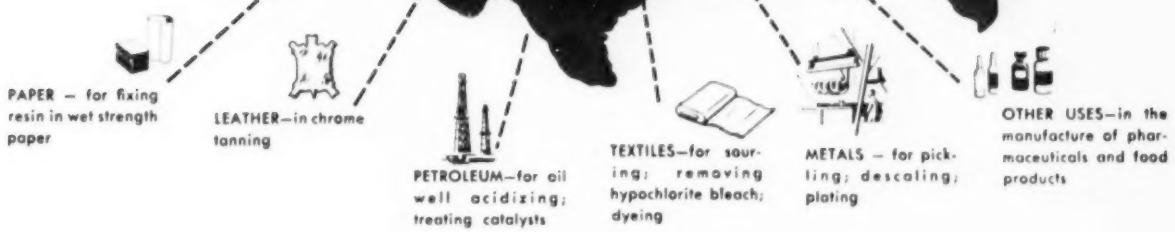

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